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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

FEBRUARY 17.

Institution of Welding Engineers (Birmingham Branch):—Ordinary meeting. "The Metallographic Examination of Welds." Paper by J. D. Jevons and M. A. Wheeler.

FEBRUARY 22.

Institution of Welding Engineers (Manchester Branch):—Ordinary meeting. "Applications of Welding to Structural Work." Paper by J. H. Paterson.

FEBRUARY 28.

Institution of Engineers and Shipbuilders in Scotland:—Ordinary meeting. "Electric Arc-Welding in Shipbuilding." Paper by J. L. Adam.

Institute of British Foundrymen.

FEBRUARY 17.

Sheffield and District Branch:—Ordinary meeting. "Mechanised Core Shops." Paper by H. F. Coggon.

FEBRUARY 18.

East Midlands Branch:—Debate at Loughborough. "Science and the Foundryman." Science: H. L. Sanders. The Foundryman: T. Goodwin.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "Some First Principles in Foundry Practice." Paper by A. Jackson.

Lancashire Branch:—Ordinary meeting at Manchester. "Some Practical Non-Ferrous Foundry Work." Paper by F. Dunleavy.

FEBRUARY 20

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting. "Aluminium Castings." Paper by F. H. Hurren.

FEBRUARY 23.

Newcastle-upon-Tyne Branch:—Ordinary meeting. "Recent researches in the Iron Foundry." Paper by S. E. Dawson.

FEBRUARY 24.

Middlesbrough Branch:—Ordinary meeting. "Steel Castings: A Practical Talk." Paper by F. Swift.

Specifications and Bonus Payments.

During a conversation with a prominent steel-foundry director last week the discussion turned upon the acceptance tests published by the great governmental departments and the railway companies. His views were that at the moment the minimum requirements were too low and they were in need of revision in order to align themselves with modern conditions. Such cases must be regarded from two angles, the business end and metallurgical advancement. Dealing with the second aspect first, high demands enunciated in a specification is an international advertisement on the grounds of quality, and as the manufacturers must be well on top of their job, it induces research and refinement of process in order that they may easily meet the demands imposed.

The business side is more complex, and high specificational demands may, for instance, restrict too acutely the source of supply. Moreover, the severity of inspection is obviously not yet standardised, and interpretation can vary from district to district.

It is, we believe, common ground that if a specification is too easy of fulfilment, price-cutting becomes more intense, and consequently reduces the amount of money available for technical experiments having for their object the production of still higher-grade material. After listening carefully to all the arguments put forward, we reached the conclusion that no case had been made out for revision, but we were convinced that there were good grounds for the creation of commercial clauses which would accord premiums for the provision of better tests up to maximum amount, as obviously the buyer must know his maximum liabilities. Such a system would enable the buying authorities to award future contracts to the most reliable firms. The addition of alloys would have to be taken into consideration, as premiums would soon be worthless to the manufacturer as a result of their use.

We are aware that our notions are revolutionary in character, but it does seem logical to us that where buyers really require the highest grade of material and obtain it, when only asking for mediocre stuff, they should show their gratitude by "material" compensation.

A Welcome Revival.

A wider circle than the foundry and engineering trades will welcome the evidence recently afforded of the revival in the shipbuilding industry, for shipbuilding is, and has always been regarded as, a particularly British enterprise. As an industry it has suffered perhaps more than any from the ill-considered subsidies which have been granted by governments with the object of maintaining a mercantile marine; it does not require much stretch of the imagination to see that payments by Europe to America, for example, in respect of war debt may have been expended in part in shipping subsidies which have been used to compete with our own non-subsidised lines.

Figures recently announced by the shipbuilders for tonnage ordered suggest that the first quarter of 1933 will show as great a tonnage under construction as for the whole of 1932, and several further orders have been placed since the announcement was made. What this means to the foundries of the Clyde and Tyne every founder will appreciate.

The deplorably low ocean freight rates which have obtained during the past few years have naturally resulted in pronounced efforts to economise in ship construction and ship operation, and some of these recent orders are for new designs which will show a material reduction both in first cost and in operation. Such vessels will be able to compete for the freight available much more effectively than those which have been laid up, and this, in itself, is bound to stimulate further building.

The improvement in the price of scrap, which has already made itself felt, will further encourage the breaking up of idle tonnage which is over ten years old, and this again is likely to stimulate still further the demand for fresh construction. The depressingly high figures for unemployment which have obtained in the shipbuilding areas for so long are therefore likely to make a favourable turn, and to improve as time goes on.

Apart from developments in the design of vessels as such, developments are also taking

place in the engines, for which foundries are well advised to be prepared, as engineers are likely to demand a quality of material and a closeness of control which has not hitherto been necessary in ordinary steam-driven reciprocating sets. Parts of the improvement referred to above is in respect of naval requirements in connection with which the German pocket battleship has produced an entirely new outlook in naval circles.

Deplorable as have been the disasters which have been suffered by the French mercantile marine from fire, and the difficulties which have been experienced on the new Italian vessels, they serve to throw into heightened relief the reliability of British design and navigating ability. It is profoundly to be hoped that the experience gained as a consequence will be utilised in connection with the completion of the giant Cunarder, and any new tonnage that may be put down, and that this completion be put in hand with a minimum of delay. If we can produce a vessel which will stand out as the Mauretania has done the pride of place in the Atlantic service may well pass back to Great Britain in spite of the efforts of America, France, Germany and Italy.

Aachen Foundry Institute Symposium.

The Foundry Institute of the Aachen Technical Academy will hold a meeting at the Naumann Institute, in Aachen, on February 24 and 25, at which a number of metallurgical Papers will be read and discussed. Invitations to be present and to take part in the discussions have been addressed to various British, French and Belgian metallurgists and foundry technologists. Two sessions will be held each day from 9.30 a.m. to 1 p.m., and from 3.15 p.m. to 7 p.m. Among the twenty Papers on the programme, Prof. E. Piwowarsky, D.Eng., will read one on the early history of foundry practice in pre-Christian times, and a second on the results of recent researches at the Foundry Institute. He will refer to work dealing with arsenic and antimony in cast iron. The production of an alkali-resisting grey iron, graphite in castings, the superheating of grey iron, scrap melting in cupolas, the production of a grey iron with negligible section-thickness sensitiveness, and the manufacture of a non-growth cast iron. Dr. E. Söhnchen will read Papers on aluminium alloys and on the mechanical properties of cast steel at temperatures above 1,000 deg.; Dr. H. Nipper will discuss the deoxidation of copper alloys; Dr. J. Wecker deals with bearing bronzes, with high lead content; and Dr. R. Sterner-Rainer discusses the use of aluminium alloys for pistons. Other Papers on the programme are:—"Metallurgy of Fusion-Welding," by Dr. W. Kleinefenn; "High-Rigidity Cast Iron," by Dr. M. Wachlert; "Analysis of the Conditions of Growth of Cast Iron, with Special Reference to the Silicon and Nickel Contents," by Dr. O. Bornhofen; "Manufacture of Tubes by the Centrifugal-Casting Process," illustrated by lantern slides and films, by Dr. Pardun; "Salesmanship in Engineering," by Dr. Th. Geilenkirchen; "Investigations on Cupolas," by Dr. H. Jungbluth; "Effect of Structure on the Wearing Properties of Cast Iron," by Dr. Th. Klingenstein; "Primary Crystallisation of Cast Iron," by Dr. F. Rall; "Mechanical Properties of Cast Iron in relation to Structure," Dr. G. Meyersberg; "Adoption of Moulding-Sand Tests in Foundry Practice and its Reaction on the Quarry Industry" (with exhibition of latest testing apparatus), by Prof. Dr. P. Aulich; and "Casting as an Economic Index of Foundry Practice," by Dr. E. Matejka. A film will also be shown by Prof. Dr. O. Bauer on the "Destruction of Lead Pipes by Insects."

Stanton Mechanical Lead Joint.

The Stanton Ironworks Company, Limited, near Nottingham, have introduced a joint which it is anticipated will take the place of the ordinary lead joint for general gas and water distribution purposes. The joint in question follows the design of the well-known Stanton-Wilson self-adjusting joint; but in place of a rubber ring, protected with a lead tip, which is used for all purposes where extreme flexibility is required, the ring consists of an all-lead ring with a thin metallic cylinder encased and hermetically sealed within it.

The Stanton mechanical lead point can be made without skilled jointers; it is no more costly than the ordinary run lead or caulked lead-wool joint when laid; possesses a degree of flexibility greater than that obtainable with the ordinary lead joint; is mechanically held in position when once made, and allows of no drawing of the lead joint, although the spigot end of the pipe is free to expand or contract.

The Stanton Company recommend that where a substantial movement between adjacent pipes has to be met, the Stanton-Wilson self-adjusting joint (rubber ring with lead-protected tip) be used, and where the nature of the ground at present admits of the use of ordinary lead joints, that the Stanton mechanical lead joint (all-lead ring) be adopted.

This joint is being put on the market for use with the Stanton De Lavaud spun pipe, in sizes up to 20 in. dia., but at the moment early delivery can only be given of sizes of 4 and 6 in. dia.

Institute of Metals.

The annual dinner and dance of the Institute of Metals will be held at the Trocadero Restaurant, Piccadilly Circus, on Wednesday, March 8, at 7 p.m. Among those who have accepted the invitation of the Council to be guests of the Institute are:—

Sir William Bragg (Director, Royal Institution); Air Marshal Sir Robert Brooke-Popham; Sir Hugo Hirst (President, Institute of Fuel); Sir F. Gowland Hopkins (President, Royal Society); Miss E. M. Kennedy (President, Women's Engineering Society); General The Hon. Sir Herbert Lawrence; Sir Murdoch MacDonald (President, Institution of Civil Engineers); Prof. E. W. Marchant (President, Institution of Electrical Engineers); Sir David J. Owen (President, Institute of Transport); Sir Joseph Petavel (Director, National Physical Laboratory); Sir Charles Grant Robertson (Vice-Chancellor and Principal, University of Birmingham); Dr. S. W. Smith (President, Institution of Mining and Metallurgy); Sir Josiah Stamp (President, London Midland & Scottish Railway); The Rt. Hon. Lord Trenchard (Chief Commissioner, Metropolitan Police).

Future of Die-Castings.—According to an article in a recent issue of "Machinery" (U.S.A.) die-castings are taking, and will continue to take, an increasingly important place in industry. The equipment for their production has been vastly improved, and die-casting alloys having remarkable strength and casting qualities have been developed. The steels from which the die-casting dies themselves are made have also been improved to keep pace with the new casting alloys. This progress has resulted in faster production, greater accuracy, and a marked increase in the size of parts made by the die-casting process.

Random Shots.

"Marksman" has just been looking through a little publication called "What's Wanted." It is a booklet, now in its third edition, which lists some hundreds of "needed inventions," compiled by the Institute of Patentees. Contained therein are suggestions for new or improved devices, that range from the considered to the patently humorous (yes, a pun a day kept Doctor Samuel Johnson away). One of the "wants," for instance, is an automatic indicator to register the entry of club "bores." Another is a method "of making the other chap see your point of view." Yet another—most urgent necessity!—is a "simple, easy way of making money." Rather vague, this, but allowing the inventor plenty of scope. Would an infallible method of winning newspaper competitions, or a means of foretelling the prices of stocks and shares six months hence, meet the case?

* * *

One particularly ingenious suggestion is a "combined pen, pencil, penknife, eraser, paint-brush, ruler, compass, magnet, sparking-plug tester, toothbrush, nail file, razor, adjustable watch key, cigarette holder, automatic lighter, corkscrew, monogram, toothpick, fitted with a clip for the waistcoat pocket." The perfect trade-mark for this contraption, surely, would be "Multum-in-Parvo." But "Marksman" views such a "super compactum" with many qualms, feels that it might easily become a public menace. All manners of things might happen if the works went wrong. One might suddenly find oneself shaving with a toothpick, cleaning one's teeth with a nail file, smoking a cigarette held in an adjustable watch key. . . .

* * *

Perpetual motion, surprisingly enough, does not figure amongst the "wants." But there is a request for a method of utilising atomic energy, an instrument for screening off the force of terrestrial gravitation, and the harnessing of the sun's electro-magnetic waves.

* * *

Some of the suggestions have a definitely metallurgical flavour, though few impinge directly on to foundry practice. A steel is wanted which is suitable for making gauges which will give no alteration in dimension when hardened, or a steel for the same purpose of such composition that on hardening it will always give uniform alteration in dimension. And then there is wanted a method of "browning" steel which will give an effective and permanent coating without requiring the use of methylated spirits.

* * *

Homeward wending your uncertain way (perhaps after a local Branch dinner or other gladsome function), it may be that you have beheld the morrow morning's milk upon a humble doorstep. You may then have sorrowfully pondered upon the fate of milk bottles exposed thus precariously to the gay fantastic toe of the newspaper boy. (One's thoughts, on these occasions, *are* liable to wander along strange philosophic paths.) And decided that the milk-distributing trade should be run by engineers. . . .

* * *

This question of bottles has interested "Marksman," too. He was not aware until a few days ago that there exists an enterprise that recovers "lost" bottles and other dairy vessels, that in 1932 it recovered no less than 9,745,472 (or 10,000,000 as the headlines have it) bottles for their rightful owners. As an important milk retailer would say (in an interview with our representative): "It's a wise milkman that knows his own bottles."

Marksman.

Institute of British Foundrymen.

LANCASHIRE BRANCH DINNER.

The annual dinner of the Lancashire Branch of the Institute of British Foundrymen was held on Saturday, February 4, at the Grand Hotel, Manchester. There were about 190 guests altogether, among whom were Mr. Ellis Flower (accompanied by Mrs. Flower), the President of the Lancashire Branch, and who presided over the proceedings; Mr. E. Shackleton Bailey, M.P. (Gorton Division); Mr. Victor Stobie, M.I.E.E., President of the Institute of British Foundrymen; Mr. V. C. Faulkner, M.Inst.M., Editor of THE FOUNDRY TRADE JOURNAL; Mr. Julius Frith, M.Sc., M.I.E.E , M.Cons.E., President of the Manchester Association of Engineers; Mr. Roy Stubbs, Vice-President, Institute of British Foundrymen; Mr. Tom Makemson, secretary of the Manchester Association of Engineers and general secretary of the Institute of British Foundrymen; Mr. S. G. Smith, Past-President of the Branch; Mr. R. A. Jones, the chairman of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen; Mr. A. Phillips, the Senior Vice-President of the Lancashire Branch of the Institute; Mr. W. N. Cook, the Junior Vice-President of the Senior Section; Mr. R. A. Miles, Manchester District Manager of the Stanton Iron Company; Mr. H. F. Coggon, August's, Limited, Halifax; Mr. John Masters, Fordath Engineering Company, Limited; Mr. Ironsides, managing director, the Vaughan Crane Company, Limited; Mr. S. P. Howden, Principal of the Openshaw Municipal Technical School, Manchester; Mr. E. Longden, Craven Bros., Limited, Reddish; Mr. J. Taylor, chairman of the Burnley Section of the Lancashire Branch; Mr. J. Pell, secretary of the Burnley Section of the Lancashire Branch; Mr. A. E. Green (Preston) and Mr. J. E Cooke, secretary of the Lancashire Branch.

Mr. A. Hodgkinson, National Founders' Employers' Association, was absent through illness, and Mr. R. Greenwood, managing director of Craven Bros., Limited, Reddish, was also unavoidably absent.

The dinner was preceded by a whist drive at which the M.C. was Mr. J. Master, and was followed by a dance at which the M.C. was Mr. H. Stead.

The Toasts.

The customary loyal toast was proposed by the President of the Lancashire Branch and was duly honoured.

The Institute of British Foundrymen.

MR. E. SHACKLETON BAILEY, M.P., proposed the toast of "The Institute of British Foundrymen," expressing the hope that the foundry industry would speedily become more prosperous. At the present time the industry appeared to be in a somewhat similar position to that of the man who had something to sell, and when he said to a prospective customer: "Will you give me £50 for it?" The customer replied, "No, but I will give you £2." "All right; I'll take it." He congratulated the Lancashire Branch upon possessing such a highly efficient and popular President as Mr. Ellis Flower. The work he was doing in training the younger members of the industry and fitting them for the responsibilities they would have to shoulder in the future was highly commendable, and most especially so when it was backed up by the remarkably good work which was being done under the auspices of Mr. Howden at the Openshaw Technical School. Although he did not claim to possess either theoretical or technical knowledge of metallography or engineering, yet he could quite freely state that he had never listened to a more lucid and convincing lecture upon those subjects than that which was delivered by Mr. Howden at the opening meeting of the year, and to which he had been kindly invited to attend by the President of the Branch.

MR. VICTOR STOBIE, M.I.E.E., President of the Institute of British Foundrymen, responded to the toast, saying that he was interested to learn that Mr. Shackleton Bailey's profession was that of the Bar. Some years ago he himself was an expert witness in a case in which the leading counsel, on behalf of the side of the case in which he was retained, was Mr. Arthur Salter, who very shortly afterwards was elevated to the Bench as Mr. Justice Salter. In the next case in which he was retained as expert witness, the leading counsel was Mr. Tomlin, and again, almost immediately afterwards, that gentleman became Mr. Justice Tomlin. Then followed a third case in which he was retained as witness, and his leading counsel was Mr. William Jowett, who became the Attorney-General and was knighted. There was still another case in which he was concerned, and this time the leading counsel for the side he represented was Mr. R. A. Wright, who was, in his turn, elevated to the Bench and ultimately became a Lord Justice of Appeal. Having regard to all these fortunate happenings in the past, therefore, he could quite foresee, from his association with Mr. Shackleton Bailey that evening, that within the next 12 months there would be news of that gentleman's elevation to the Woolsack. (Cheers.)

Mr. Shackleton Bailey had spoken most felicitously of the work of the Institute, and he could not have spoken to a Branch which deserved those words of commendation more than the Lancashire Branch, which had shown a wonderful increase of membership to the extent of something like 42 per cent. of the total increased membership of the whole of the Institute.

One of the methods by which all the Branches, and possibly the Lancashire Branch in particular, could make an attempt to promote still further progress of the Institute would be by discussion, at the social gatherings they held after their meetings, of the various appliances used in the industry, with a view to their further improvement, and also with regard to the possible introduction of newer and better ones. If some really valuable conclusion was arrived at, then it could be submitted to the whole of the Institute for further consideration, and, perhaps, a device could be patented from which an income could be secured to the Institute for many years to come.

The Lancashire Branch.

MR. V. C. FAULKNER, M.Inst.M., Editor of THE FOUNDRY TRADE JOURNAL, in proposing the toast of "The Lancashire Branch," referred to the suggestion made by Mr. Stobie with regard to the taking out of patents for new appliances, pointing out that that gentleman had overlooked the fact that the Institute was not a trading organisation. The Institute's affairs were controlled by Royal Charter, and such a function was, perhaps unfortunately, quite outside its purview. He, also, would like to associate himself with the eulogistic remarks concerning the excellent work done for the Lancashire Branch by its President, Mr. Ellis Flower.

MR. R. W. STUBBS, Vice-President of the Institute, supported the toast, congratulating the Lancashire Branch upon the many very highly-efficient Presidents it had had in the past. There was certainly every indication that future Presidents would not be less able than their predecessors. The Lancashire Branch was also to be felicitated upon the rapid way in which it was increasing its membership, in forging ahead to a remarkable degree in regard to the Papers which were read before it, and the keenness of the discussions which took place upon them.

MR. ELLIS FLOWER, in responding to the toast, said that having regard to the high status to which foundrymen generally had now raised themselves he felt very proud to be able to refer himself as a foundryman also. Of course, personally, he was very much concerned at the present state of the founding trade, and he felt obliged to speak in terms of deprecation of the cut-throat competition which was at present prevailing. It was certainly one of the causes of the general financial depression. If it did not cease more foundries would probably go into liquidation, and the ranks of the unemployed be swelled in numbers.

There was, however, another aspect of the situation to which he would like to refer for a moment. At the latter part of November last year, a payment of 30 million dollars was due from this country to the U.S.A., and for which we had then made no provision. The newspapers were devoting a great deal of attention to the problem. Before that crisis came to an end, another crisis arose, namely, the cricket test match in Australia. Until the result of that test was known, he ventured to say that 99 people out of every 100 in this country had forgotten all about our debt to America. When it did become known we simply put our hands in our pockets and paid over 19 million pounds in gold. His own view was that a race of people who were psychologically able to place sport before a financial crisis of that description had the ability and the power to overcome even the terrible problem of unemployment which was at present confronting them. When he looked around him and saw the serious state of all the other countries in the world, he still felt that England was the finest country on God's earth.

The Ladies and the Guests.

MR. ELLIS FLOWER then proposed the toast of "The Ladies and the Guests." Anyone who knew anything at all about foundrymen was aware that for 364 days in the year their faces betrayed an appearance of continual trouble and worry and even misery. On the 365th day their countenances were wreathed in smiles because it was the day of the annual dinner. No one would think, looking around the tables that evening, that any one of them had sat upon an inquest concerning a bad casting. This was due to the presence of the ladies. Ever since the ladies had been invited to the dinners, now some 10 or 11 years, they had been a huge success, and he desired to express his own, and every other member's, thanks to them for the kindly interest they had taken in the welfare of the Institute. It was also a very pleasant factor to find that so many guests had found it possible to attend the dinner, and helped to stimulate the feeling of good fellowship generally. He would, furthermore, like to add a word of very deep appreciation for the services rendered by its general secretary, Mr. J. E. Cooke, whom he, personally, regarded as one of the ablest stalwarts the Branch had ever possessed.

MR. ROY STUBBS, in supporting the toast, mentioned that before ladies were invited to attend the annual dinners the attendance was very small. Acting upon the suggestion of Mr. Miles, it was decided to invite the ladies, and the attendance immediately jumped up from about 50 to 150.

MRS. ELLIS FLOWER responded to the toast in appropriate terms.

Presentation of the Diploma.

MR. VICTOR STOBIE then made the formal presentation of the Diploma of the Institute to Mr. W. West, of Preston, as a recognition of the valuable work done by that gentleman for the Institute during the past session. Owing to the unavoidable absence of Mr. West, the Diploma was received, on his behalf, by Mr. A. E. Green.

A Few Foundry Problems.

Mr. Walter Fearnside, the speaker at the West Yorkshire Branch of the Institute of British Foundrymen, at their December meeting, presided over by Mr. R. D. Welford, Vice-President, after referring to the dearth of apprentices, and the increased skill demanded from the modern moulder, dealt with the stringent demands of the engineer for a combination of machinability and wearing properties and similar complexities. In his remarks on the design of castings, Mr. Fearnside said we foundrymen were rarely consulted. Not for a moment do designers consider questions as to how it was to be accomplished, whereas a few minutes' talk with the foundryman might have greatly simplified the moulding of the job. He had in mind a rather large casting which had a large number of cores, with bosses of a different length all made from one core box and the bosses were interchanged. They were marked in the well-known method with indication letterings until almost the whole alphabet had been used. Several of these castings had been made successfully, but not without a good deal of checking of cores, when the usual thing happened—one of the bosses in the wrong place. It later transpired that there was no need for such differences. Another case referred to a crank-case for a marine engine. This had a mean thickness of $\frac{5}{16}$ths, was full of ribs, and had bearing seatings and exhaust pipes cast in. The casting was 6 ft. long, 2 ft. high and 2 ft. wide. It had to pass tests for water pressure and, of course, being an engine crank-case it had to be a very sound casting. As there were about 80 cores, and each one different, it will be realised this was a very delicate job. But the real trouble was not in putting it together, but getting the exhaust pipes well to stand the water pressure. The difficulty was that they had a tendency to cold lap at the top side owing to the fact that there was no flow of metal, and also that the metal before it reached this point had had to pass through about 18 in. of mould and thus had lost a good deal of its life when it came in contact with the chaplets holding the pipe cores in position. To overcome this he caused a number of small holes to be made through the cores which covered the pipe cores, and in this way allowed the metal to flow past the chaplets, and so, where the two sections of metal met and caused a cold lap, this riser through the core helped the metal to join together. When making this casting no vents are taken off the cores. In most of the cores it would be impossible, and, owing to the casting being so thin, it set before gases have time to cause any trouble.

Costing.

Supplying castings at an all-in price is wrong, both to the engineer and the foundryman, owing to the large variation in time taken to make them. Take, as an example, a similar casting to the one just described. Consider the time it would take in core-making, moulding and fettling—probably about 100 hours. Then compare it with the flywheel for the job—which takes a matter of 4 hours. Now, supposing the more complicated part breaks whilst at work and the engineer simply orders another, which at an all-in price would undoubtedly prove a loss to the foundry. But supposing the heavy casting had to be replaced, which, of course, was very unlikely. The engineer would either have to get the foundryman to lower his price or he himself sell at a loss. This was one of the reasons why foundrymen get a better perspective and sell at a price per piece.

"Semi-Steel."

The problem of uneven contraction has in recent years been considerably increased owing to the fact that somebody had the idea that by adding a certain percentage of steel the metal would be improved. This results in increasing the spongy places in castings, and also when the castings are being machined hard spots are found. This mixing, which goes under the high-sounding title of "semi-steel," is giving the engineer the idea that he is getting a much better casting than would be the case if made from the old-fashioned cast iron; but actually a better result can be obtained by a good mixture of cast iron—one to suit the type of casting to be made—than one from a mixture of scrap and steel. When steel is added to cast iron one must be prepared for heavy shrinkage. Some will advocate denseners in moulds to reduce this danger, but even the densener does not do away with the shrinkage; it only removes it from one part of the casting to another.

Machining Allowance.

The matter of machining allowances is another vexed question which the foundryman must take cognisance of since this new high-speed tool steel has come on the market. The engineer now insists that to-day he can do without going underneath the black. He can cut straight into it, therefore he can do with less. It seems reasonable that owing to the fact that he can machine castings at such high speed that is all the more reason why he should make the allowances larger. The system of making a uniform allowance on all types of castings and on all sides of them is entirely wrong. An increase in machining allowance would not in the end increase the cost of the machine to be produced, because of the potential saving of time now lost in machining faulty castings.

Another difficulty arises from large patterns being made in sections, and may, by putting in or taking out, be used to make long or short castings of the same type. These sections begin to get out of shape both by being used and also from natural causes, such as the drying in of the wood, and eventually when they are put together may vary as much as $\frac{3}{8}$ in., an amount which in the case he mentioned was the machining allowance of the job. The moulder was expected to see these were correct when the casting was made. Camber is another thing which, if the machining allowances are small, can very easily cause a good sound casting to be scrapped. No moulder can safely say how much camber is required for the first casting.

Venting and Beds.

Making a large casting in greensand without venting the bed offers problems. Much valuable time and energy is thrown away in putting vents in the bed of greensand moulds. It is the floor sand behind the bed which is the cause of the trouble and not the bed itself. The pit is worked year in and year out and in time becomes almost like concrete, and no amount of venting will allow the gases to escape from the face of the mould when this is the case, because only the fine point of the vent wire touches the coke, and this is insufficient. It is preferable to have the coke bed about 2 ft. away from the face of the mould, and in this way keep the sand open and free for the gases to pass from the face of the mould into the coke bed. His method was to dig out to the top of the bed and then begin to make it firm by treading for the last six inches or so. The sand was put through a quarter-mesh riddle until there was about 2 in. above the straight edges. This is then gone over gently with the flat-headed rammer and then the bed is strickled off. He has no confidence in the idea which was carried out a few years ago of making a facing-sand bed of about 1 in. thick, but instead take a $\frac{1}{8}$-in. sieve and just cover the face of the bed, and this smoothed over gives a much better result than was given by spending hours venting. In making a bed of this description he always ran the metal slightly upwards, for the simple reason that when a bed is made level the metal which enters the mould first is liable to cause scabs by there not being enough bulk to drive the gases downwards.

The difficulty one has in a general foundry in regard to having large box-parts which may be used for all kinds of castings, is a very considerable and costly one, especially if they are made in one piece. All foundries would, when making a large box-part, have much less expense if it were made in sections. Made this way they are much more easily adapted to the various patterns to be made in them. Loose ends may be used to make the box either wider or narrower as the job demands, and loose bars are easily made to suit the job, whereas if fast bars are cast in they are usually broken to fit each change of pattern, and in the end the box becomes a mere skeleton. When made in sections, too, the sides of the box, which from time to time get broken, are more easily replaced. When loose board boxes are used, jobs which involve having a very deep joint or drawback, can be made with a straight joint by throwing the portions which would have to be lifted by irons or gaggers up into the top part, and this enables the job to be finished much more satisfactorily than the case where the joint is too deep to allow the top part to be turned over and the moulder has to go underneath the top part to finish.

DISCUSSION.

The Chairman (Mr. Welford) said the question of moulding large castings without venting the beds was carrying to a logical conclusion the methods the loam moulders used when making large building or similar plates up to 20 tons weight. As Mr. Fearnside had said, the loose sand absorbed the gases. Mr. Welford thought the idea of the inclined bed was excellent, controlling as it did the stream of the metal.

Mr. J. J. Watson (Huddersfield), speaking of the bed to which particular reference had been made in regard to venting, asked whether Mr. Fearnside used any stronger sand where the runner entered the mould or used any other special precaution against the hot spot resulting from the entry of the metal.

Mr. Fearnside replied that usually owing to the opened front of the runner he added nothing in, as there was no great force entering; but when running a very heavy plate he may sometimes put a core in front and let it into the bed, or put some flat-headed nails where the runner entered. He used no stronger sand.

Mr. W. Parker said steel was added to mixtures only to closen the grain by altering the silicon content. He had himself been melting this semi-steel for some time, and could hardly understand anybody having an difficulty in the matter of hard spots. He would never hesitate to use it if melted hot enough, and, of course, incorporating a good steel, not rusty material.

Mr. Fearnside, replying in reference to semi-steel, said he had had it tested against a good mixing of cast iron, and obtained a better result from the cast iron, so he did not yet see what advantage there was in using steel mixed with cast iron.

Mr. S. Carter (Huddersfield) remarked that cheapness was the main factor about the semi-steel cast iron. It could be produced cheaply and easily, and he had not encountered anybody who had had difficulty with hard spots when the material was melted at a suitable temperature.

Mr. A. W. Walker (Huddersfield) said it was true there was a difference in the melting point as between the steel and the iron, but this difference can be bridged by using a high manganese iron.

Mr. Fearnside said that a good cast iron avoided any risk of shrinkage trouble which was liable to arise in heavy sections in semi-steel castings. He knew that the semi-steel was a cheaper mixture.

Mr. S. Carter observed that it also produced a higher strength material.

(*Concluded on page* 132.)

Aluminium Bronze.

By Frank Hudson.

(*Continued from page* 107.)

Reverting back to the runner section, it was found that when this was fractured for removal, the chill cast portion adjacent to the ingot exhibited a fine-grained fibrous structure, whilst at a point about 2½ in. away, in the sand-cast portion, the fracture was coarsely crystalline.

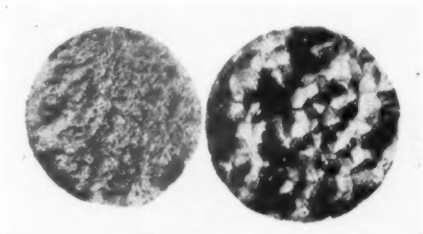
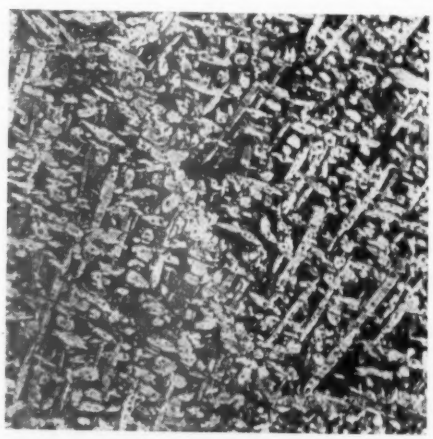


FIG. 25.—FRACTURE (LEFT) OF CHILL, AND (RIGHT) 2½ IN. AWAY FROM IT.

Fig. 25 shows the appearance of the two fractures. The coarse crystalline structure is typical of that usually obtained from fractures of water-quenched aluminium bronzes when in the beta



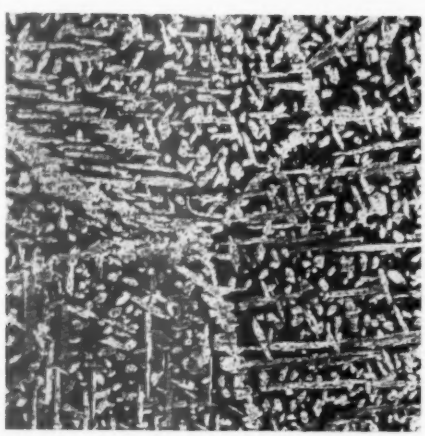


FIG. 26.—(ABOVE) CHILL CAST. × 100. (BELOW) SAND CAST. × 100.

state, and is also associated with rapidly-cooled sand-cast section of the 10 per cent. aluminium alloys. Test results show this fracture to be associated with brittleness and low elongation values and is to be avoided as far as possible.

Microscopical Tests.

A microscopical examination was conducted with a view to solving the problem and the results obtained are shown in the following illustrations:—

Fig. 26 shows microphotographs of the sand and chill cast sections at 100 magnifications. The structure is representative of the alpha-beta phase and little difference can be detected between the sections to account for difference in

FIG. 27.—SAND CAST. × 1,000.

fracture. Fig. 27 is a microphotograph of the sand-cast runner portion at 1,000 magnifications. The constituents present are alpha, beta and delta. The delta phase has not photographed up very well, but could be easily picked out under the microscope. In Fig. 27 the delta

FIG. 28.—CHILL CAST. × 1,000.

is the darkest coloured constituent. Particular attention should be directed to the structure of the beta phase.

Fig. 28 represents the chill-cast portion at 1,000 magnifications. Again, there are present the alpha, beta and delta constituents. The delta constituent is more clearly shown around the alpha boundaries, but it will be noticed that in comparison with the previous slide the beta constituent is more laminated in appearance. This tends to denote a slower rate of cooling, which in all probability accounts for the difference in fracture.

Fig. 29 shows a microphotograph of the runner cut down the centre as cast, and after quenching and tempering. The slightly thicker section in

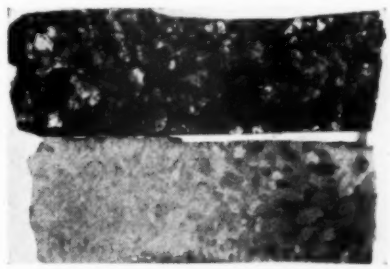


FIG. 29.—CENTRE OF THE RUNNER (ABOVE) AS QUENCHED AND TEMPERED; (BELOW) AS CAST.

each case is representative of the chilled portion giving the good fracture. After quenching at 900 deg. C. in water and reheating to 650 deg.

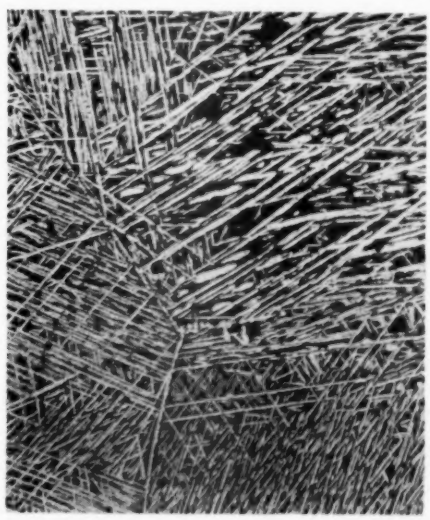


FIG. 30.—HEAT-TREATED RUNNER SECTION. × 100.

C. for ½-hr. cooling in air, the chill-cast section gave the same fracture as the original sand-cast section. This tends to prove that the assump-

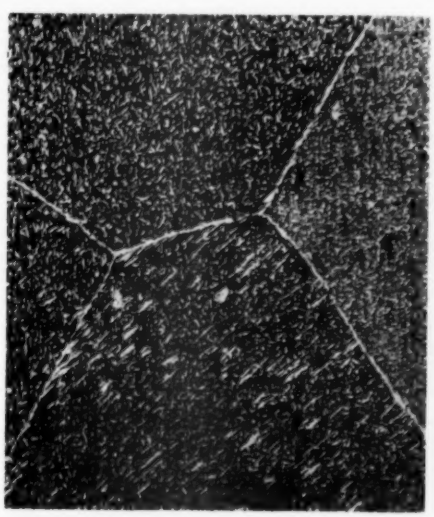


FIG. 31.—SAND CAST ALUMINIUM BRONZE (10 PER CENT. AL). × 100.

tion given above, regarding the cause of the crystalline structure, being due to too rapid cooling is feasible. As a matter of fact, per-

sonal experiences in regard to the use of aluminium bronze containing between 9.5 and 10.5 per cent. aluminium has not been too satisfactory, due to the frequent production of material exhibiting the above fracture, and now an aluminium content of 9.5 per cent. is not exceeded.

One is warned by text-books that brittleness in aluminium bronze can be caused by "self-annealing" through slow cooling, but personal opinion is that rapid cooling in alloys of higher-

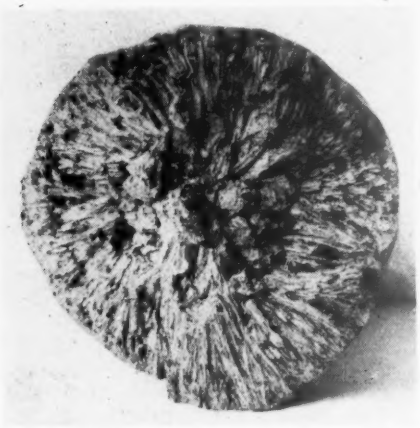


Fig. 32.—Fracture due to Oxide Segregation.

aluminium content (9.5 to 10.5 per cent. Al) is equally as dangerous, and can promote brittleness to an extent equal to "self-annealing." Apparently, alloys in this range are so susceptible to cooling influences that if a 1-in. thick section is normally cast in sand, cooling is sufficiently rapid to cause brittleness. Alloys containing more than 9.5 per cent. aluminium should be avoided so far as castings are concerned and only employed for ingots when sections and conditions are such as to warrant their

Fig. 33.—An Etched Section of Fig. 32 Revealing Cracks.

use. These remarks apply with equal force to heat-treatment of high-aluminium content alloys, as once the beta-phase has been formed by quenching, subsequent tempering operations require slower-cooling conditions to ensure the removal of brittleness than is required by alloys of lower-aluminium content. The structures in the next two macrophotographs, shown by Figs. 30 and 31, are also commonly associated with the brittle crystalline condition. Fig. 30, at 100 magnifications, is the heat-treated runner section previously mentioned after quenching and tempering, and Fig. 31 at similar magnification is another sand-cast section containing around 10 per cent. aluminium. Both these photographs illustrate structures approaching the full beta-phase, and being associated with brittle material they should be avoided. This statement can apply with equal force to other non-ferrous alloys used for structural engineering work, such as

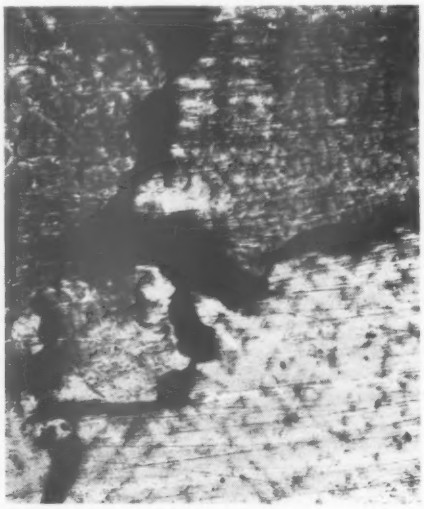


Fig. 34.—Showing how Cracking follows the Grain. × 100.

manganese brass, etc. There is a fruitful field for further research on the heat-treatment of the aluminium bronzes containing over 9.5 per cent aluminium.

Main Cause of Defects in Aluminium Bronze.

The major causes of defective work likely to arise in the production of aluminium bronze are probably due to:—(1) Oxide segregation; (2)

Fig. 35.—Shows the Inter-Crystalline Cracks at 1,000 dia.

"self-annealing"; and (3) badly-balanced composition combined with unsuitable conditions of cooling or heat-treatment. This last point has been partly covered in the last section, so it is proposed to comment only on the first two points relative to oxide segregation and "self-annealing."

Oxide Segregation.

Oxide segregation caused through improper melting or pouring is very troublesome in castings which have to be machined, as the aluminium oxide blunts tool edges, but probably the greatest source of danger from this point lies in forging operations. Fig. 32 illustrates the fracture of an ingot due to this cause. This particular ingot was badly melted and also poured from the top with a good deal of splashing. With the first few blows of the hammer the ingot was badly split. Fig. 33 shows an etched transverse section, and it is interesting

Fig. 36.—Cracked Ingot.

to note that internal cracking has taken place at the junction of the chilled and free primary crystals. At this point one would expect to get oxide segregation if this were present. Fig. 34 is a microphotograph showing that this internal cracking follows the grain boundaries, and under a still high magnification evidence of the presence of oxide at the grain boundaries is

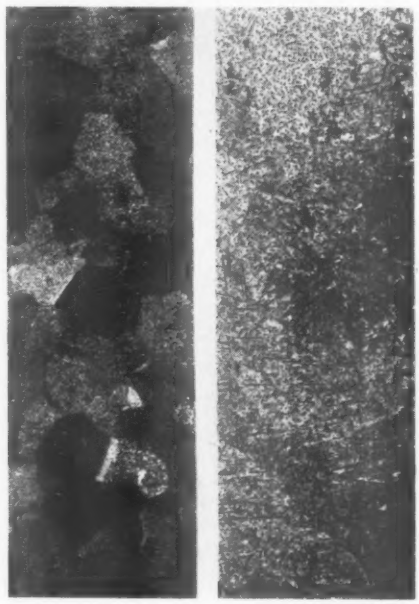


Fig. 37.—Normal. Fig. 38.—"Self-Annealed." × 3.

obtained, as shown by Fig. 35, taken at 1,000 magnifications. Fig. 36 shows another ingot fracture due to a similar cause.

"Self-Annealing."

Text-books invariably state that this is an outstanding peculiarity of the aluminium bronzes to be guarded against. Personally, the author has not yet encountered this condition in practice, and he does not think it need cause con-

cern to founders or metallurgists interested in these alloys. "Self-annealing" is applied to the aluminium bronze when a brittle condition

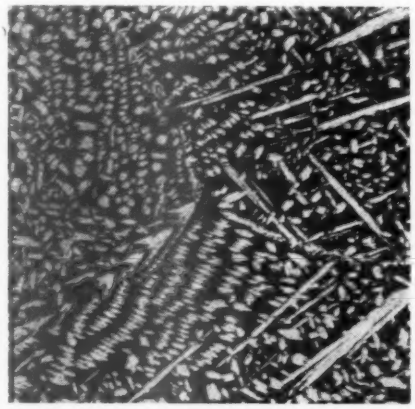


FIG. 39.—NORMAL ALUMINIUM BRONZE. × 100. 10.39 PER CENT AL, 1.12 PER CENT. FE, 0.76 PER CENT. MN.

is imparted through the presence of the alpha-plus-delta eutectoid caused by very slow cooling. Theoretically, it should not occur in alloys

FIG. 40.—"SELF-ANNEALED" ALUMINIUM BRONZE. 10.64 PER CENT. AL, 0.17 PER CENT FE, 0.72 PER CENT. MN.

containing less than 9.8 per cent. aluminium, but in practice it can be produced in the bronzes containing between 8 and 11.0 per cent. alumi-

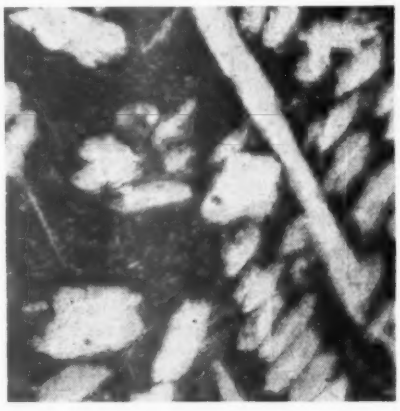


FIG. 41.—NORMAL ALUMINIUM BRONZE. × 500. 10.39 PER CENT. AL, 1.12 PER CENT. FE, 0.76 PER CENT. MN.

nium. Providing the aluminium content does not exceed 9.5 per cent., the trouble of "self-annealing" is not likely to occur unless very large sections around 10 in. thick are normal practice. If it does occur, it can be corrected by the simple heat-treatment operation of quenching and tempering, or by taking the necessary steps to obtain quicker cooling conditions, particularly between 550 and 250 deg. C. In alloys above 9.5 per cent. aluminium the tendency for "self-annealing" to occur is greater, and its correction rather more difficult, as such alloys are so sensitive to cooling conditions, that, as pointed out previously, rapid cooling can cause brittleness quite as readily as slow cooling, and consequently the cure is just as bad as the disease. Figs. 37 and 38 illustrate a macro print of normal and "self-annealed" material containing around 10.5 per cent. alumi-

FIG. 42.—"SELF-ANNEALED" ALUMINIUM BRONZE. 10.64 PER CENT. AL, 0.17 PER CENT. FE, 0.72 PER CENT. MN.

nium. It will be observed that the normal crystal grains have enlarged to such a point that one gets the impression of many grains merging into one.

Figs. 39 to 42 illustrate a microscopical study of the resulting structures, showing a complete breakdown of the normal alpha-beta phase to one of free alpha plus alpha-delta eutectoid. The appearance under the microscope of the alpha-delta eutectoid is not unlike the pearlitic

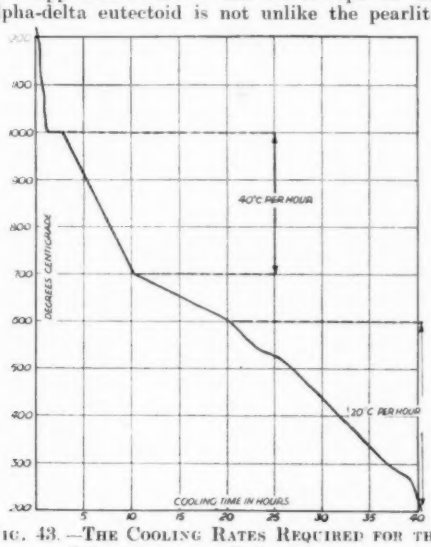


FIG. 43.—THE COOLING RATES REQUIRED FOR THE "SELF-ANNEALED" STRUCTURES.

structure associated with the iron-carbon alloys. The presence of "self-annealing" can be always readily recognised by: (*a*) Low-tensile strength and low-elongation values; (*b*) the merging of grains into one as shown by the macrostructure; and (*c*) the distinctive microstructure of the alpha-delta eutectoid.

Fig. 43 gives a schedule of the cooling rates required to produce the "self-annealed" structures in the present instance.

(To be continued.)

Action of Zinc in Blast Furnaces.

The presence of zinc in the blast furnace adversely affects the efficient operation of the furnace by increasing the coke consumption, causing the formation of scale on the lining, contaminating the iron and also breaking up the furnace lining. In a recent issue of "Stahl und Eisen" an account is given of observations of these effects in a number of blast furnaces.

Zinc oxide is only reduced by gas free from carbon dioxide at a temperature between 1,100 and 1,300 deg., *i.e.*, in the region of the bosh and the hearth. As metallic zinc has a boiling point of 920 deg., zinc vapour ascends the shaft, some escaping with the gases and some being deposited in the colder zones of the furnace. The pores in the ore and coke thus become blocked with a fine deposit, which may to some extent protect the coke against premature combustion. The ore, on the other hand, is rendered impermeable to the gases, and its indirect reduction consequently more difficult. As a result the consumption of coke is raised, while in addition more coke is required for the reduction and repeated volatilisation of the zinc collecting near the hearth.

The amount of zinc volatilised during reduction was measured, in the observations described, at different levels in the furnace, and as much as 1 kg. of 98 per cent. zinc and 1.5 per cent. lead found to collect at certain levels per hour. The largest deposits were found 2 to 3 m. below the stock line and consisted of a yellow mass of zinc oxide, while 5 m. below this level the deposit was a greyish yellow. Below a depth of 8 m. no zinc was found. The zinc deposited at the walls mixes with liberated carbon and ore-dust to form massive adhesions which slowly increase in size until they are detached and carried down by the burden. On arrival at the hotter zones near the hearth, the zinc enters the melt owing to the absence of coke for volatilisation and reduction. The slag becomes viscous and the temperature of the molten iron reduced by 100 deg., so that it cools rapidly on tapping. The surface of the iron obtained is marked with holes as found with a high sulphur content. Although the composition of the iron is hardly changed, its physical properties are adversely affected.

The volatilised zinc also penetrates the pores of the furnace lining, where it becomes oxidised and undergoes a considerable expansion in volume. The lining becomes soft, and avenues are opened for the penetration of carbon, with the result that a gradual crumbling of the lining takes place. Samples of lining were taken at intervals of 10 cm. from two furnaces to investigate this effect. In the older of the two furnaces the lining was hard only to a depth of 10 cm. at a point 4½ m. above the bosh; the next 20 cm. were soft and contained 23.3 per cent. ZnO and 23.5 per cent. carbon. The top surface was mainly ore-dust containing 19 per cent. ZnO, 14 per cent. PbO and 1.7 per cent. C. Seven metres above the bosh the lining was 25 cm. thick and covered by a deposit 2 cm. thick composed of 63 per cent. zinc oxide. In the second and newer furnace the lining, at levels 1 and 5 m. above the bosh, was still as new, but light-blue from a depth of 20 cm. the colour increasing with depth. The colour and hardness indicated the formation of the spinel, zinc aluminate, Al_2O_3, ZnO. Five metres above the bosh a soft zone suddenly commenced at a depth of 35 cm. and contained 32.8 per cent. ZnO and 14.7 per cent. C. The same was found 1 m. above the bosh at a depth of 50 to 60 cm., with 9.8 per cent. ZnO and 14.3 per cent. O. A high zinc value is thus always associated with a high carbon value. The lower part of the shaft is not attacked to the same extent as the higher part, as the temperature is too high for the zinc to become deposited.

Cupola Control—Its Progress, Practice and Value in the Iron Foundry.*

By E. Wharton.

Introduction.

The recent improvement in the design of cupolas and also in the method of their operation has revived considerable interest in an old foundry subject. When a new idea is put into everyday practice it often leads to further study of basic principles. Since "Necessity is the Mother of Invention," to quote an old proverb, any improvement in the technique of a subject often induces still further improvement. In common with other allied foundry operations, the cupola is linked up with many other matters, which, although important, may be, and often are, overlooked in the consideration of what is primarily a melting process. If really successful control is to be maintained these external matters must be kept in view.

We may say, then, that problems relating to cupola control fall broadly into two classes: (*a*) Indirect problems and (*b*) direct problems. The separation of the two classes is effected by placing in the direct class those problems which purely concern the melting of the iron. Amongst the indirect matters are those concerned with the raw materials before charging, and also the treatment of the iron immediately after tapping, but before casting into the mould.

Improvement in Materials.

Glance for a moment at the indirect matters preceding the melting operation, and notice the improvements of recent years, improvements which are being amplified to give either better material, or quality, at a lower price, both of which are vital to the founder. Take, for instance, pig-iron production from blast furnaces. The open-topped furnace, with its consequent waste of fuel in the loss of top gases, has given way to the more economical bell-topped type. Later, greater economy and better control of quality became essential. A practical method of attaining these is seen, for example, in the charging control panel. By this panel the furnace operator responsible for charging may control the height of stock in the furnace, and also place charges in correct rotation and position by a revolving bell. This aids the production of a uniform product.

In a similar way coke production has improved so that it is now possible to obtain regular supplies of fuel containing a minimum of 90 per cent. fixed carbon having the necessary strength and porosity to give efficient combustion in the cupola. The advance in coke production has entailed washing and blending of coals, finely grinding the clean slack, and attention to many points outside the scope of this Paper. These are only two examples illustrating the need for attention being paid to apparently indirect matters. The modern standard of cupola control and practice can never be realised without due regard to them.

Progress in Cupola Design.

Now consider for a while the progress in cupola design. We find, first of all, that here two types of developments have taken place. One has dealt purely with fuel economy and the other in the mechanical equipment as seen, for example, in mechanical charging. Since the introduction of more expensive fuel in the form of coke, designers have been engaged in problems concerning the complete combustion of fuel. Every foundryman is now, without doubt, familiar with the general method of cupola melting. Air is necessary for combustion, and this has been introduced in many ways, through tuyeres, which have been of endless variety and number.

Centre-Blast Cupola.

Probably no early type was more outstanding than the centre-blast cupola as used by West. Although this idea had been put forward previously, it remained to West to make a successful attempt to use the method. He endeavoured to distribute evenly the air through the coke bed, in order to obtain more complete combustion. The method never came into general use owing to the previous practical difficulties associated with the insertion and protection of the tuyere. That the centre tuyere was the outcome of considerable thought is without question, and although at the time it was ridiculed, it was a very definite step in cupola progress.

Electric Fan.

With the introduction of the electric fan more and more attention was directed to the amount of air put into the cupola in relation to the quantities of fuel used and iron melted. It was soon found that volume did not mean everything. The chemist was easily able to demonstrate that a definite weight of available oxygen was required, and that as the temperature and humidity of the atmosphere vary, so the weight of oxygen of a given volume of air also varies.

The Constant-Weight Method of Blowing.

In the pursuance of this, the automatic blast-gate control was devised by H. W. Crawford, of America. This is a clever variation of the use of the electric fan. In a Paper, published in 1929, Crawford showed than 2.66 lbs. of oxygen were required completely to burn 1 lb. of oxygen. Exactly 11.517 lbs. of air contain this amount of oxygen, and from this basis of perfect combustion he developed the constant-weight blowing fan. He placed a gate between the blower and the cupola, and controlled it by an ingenious electrical device. Any change in atmospheric conditions or in cupola restriction is compensated automatically by the blast gate. The equipment consists of a reversing motor geared to the gate, with a large-gear ratio, limit switches preventing the gate from jamming. When the current increases slightly, contact is made and current passes through the contact coils. A small $\frac{1}{25}$-h.p. motor is started, and, this being caused to run in the proper direction, closes the blast gate. By this, and a reverse operation, the weight of air is kept constant. Different settings of the apparatus can be made when variations occur in the fixed carbon of the coke or when the cupola-bore dimensions are altered.

Whilst this method of control appears to have obvious advantages in countries where atmospheric temperatures, and humidity, vary between wide limits, the same advantages do not accrue in a more temperate climate like ours. Cupola-blowing equipment, in this country, has therefore developed chiefly along the line of constant-pressure blowers. Where minor variations are necessary, they are made possible by the use of variable-speed motors, thus individual needs can be easily met.

Heat Value of Carbon.

As the value of efficient combustion came to be more fully realised, more and more attention was given to this side of control. It is a fact that the carbon burning to carbon monoxide (CO) only produces 4,450 B.T.U., whilst carbon burning to carbon dioxide (CO_2) produces 14,544 B.T.U. Thus two-thirds of the heat may be lost by incomplete combustion. Foundrymen, from the cupola point of view, are chiefly concerned with the heat transmitted to the metal during melting and superheating. Cupola designers, therefore, attempted to attain complete combustion in various ways. In this phase of progress it became, then, a question of how to obtain the maximum number of heat units. Three methods have been used in endeavours to attain this end.

The first method is seen, for example, in cupolas in which a single row of tuyeres are used. Here the aim is to burn the coke to carbon dioxide at one level. This is not easy in actual practice, owing to excess of air or coke. A second method is illustrated by cupolas where multiple rows of tuyeres are used. In these some of the coke is burned first to carbon monoxide and the gas thus formed is burned to carbon dioxide at a higher level. Thirdly, the designers heated the blast by using the waste heat from the cupola.

Hot-Blast Cupolas.

Dealing with the third methods of conserving heat units first, there are two methods of heating the blast in use in America to-day.

The Moore Hot-Blast Cupola.—In a Paper presented by Mr. J. T. MacKenzie, before the American Foundrymen's Association in 1931, a method of pre-heating the blast is described in which air is passed through pipes suspended vertically inside the cupola. The air enters the pipes from an annular wind belt outside the cupola. Passing downwards through the pipes, it is led out into a distributing ring, and then forward to the tuyeres. The average temperature of the blast is 150 deg. C., and on comparison the hot blast shows a coke ratio of 10.4 to 1 as against 7.1 to 1 previously obtained when using cold blast. The blast pipes often fail due to the pipes cracking, although the average life of the pipes is about 75 heats of 20 hrs. each. It should be observed that full advantage of any hot-blast method is not obtained unless the cupola is continuously operated. Several hours elapse even then before the cupola becomes sufficiently warmed up to enable a reduction of coke to be made. A second type of hot-blast cupola is seen in that patented and styled.

The Griffin Hot-Blast Process.—A method which has gained considerable ground in America. Here the blast is preheated in a chamber separate from the cupola. By means of a suction fan the gases are first withdrawn through a combustion chamber and then through pipes contained in another specially-constructed chamber. The incoming air, from the blowing fan, surrounds the pipes in this chamber, absorbs heat and enters the cupola at a temperature of about 315 deg. C. A saving of 25 per cent. of the coke is claimed for this system along with other advantages.

How Heat is Lost in the Cupola.

As fuel economy is dependent upon the conservation of heat, it will be worth while to consider the manner in which heat is dissipated in the cupola. In ordinary practice it is estimated that the thermal efficiency only averages 40 per cent.; this means that only 84 lbs. of the coke is consumed in actually melting the iron out of the 2 cwts. which are usually charged in melting 1 ton of iron.

The other 60 per cent. of heat is lost in many ways, such as (1) by the incomplete combustion already referred to. This is shown by the flame often seen at the charging door, i.e., heat is being generated away from the melting zone; (2) some heat is lost by radiation; (3) the cupola lining absorbs heat, the thicker the lining the greater the absorption; (4) the formation of the slag requires heat, both in the dissociation of the limestone and in the fusion of the slag. More heat is also lost by the slagging operation if not carried out efficiently, and (5) the inactive gases (CO_2, N_2 and moisture from the coke, etc.) passing from the stack carry away sensible heat. These are the main sources of heat losses.

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

In the hot-blast process where a regenerator is used, it is admitted that the gases withdrawn carry unburnt carbon monoxide. This denotes, of course, that complete combustion has not taken place at the melting zone. Plant of this type is necessarily expensive and is only of value, as already mentioned, when run continuously. Since the introduction of this method a considerable step forward has been made in the cold-blast type of cupola, so that a large saving in coke is obtained with less initial expenditure.

Attention has already been drawn to types of cupolas having multiple rows of tuyeres. Cupolas having two rows of tuyeres were the forerunners of these. Passing over types such as those of Greiner and Erpf, and also of Poumay, etc., one arrives at the most recent developments of special cupolas. This is seen in the *balanced-blast cupolas* as designed by Mr. J. E. Fletcher, of the British Cast Iron Research Association. After considerable study of the problems relating to combustion, both in cupolas and blast furnaces, he found that auxiliary tuyeres were essential. His method differs from others, however, in that he burns the fuel to carbon monoxide in the lower part of the coke bed by means of air admitted through a main row of tuyeres which are independent of the main wind belt, and fitted with controlling valves. Having thus secured a reducing atmosphere for the molten metal to pass through, a most important point, the carbon monoxide is burnt at a higher level, by means of two or three rows of small auxiliary tuyeres. Each of the small tuyeres may be adjusted by means of a brass inner sleeve, and thus by adjusting the main and auxiliary tuyeres in conjunction with each other, a balanced condition is obtained. As a deep incandescent coke bed is produced, melting proceeds rapidly in a reducing atmosphere, giving metal free from the evil effects of oxidation. The main tuyeres are kept clear by means of an excellent slide arrangement which enables the operator to shut off tuyeres alternately by pushing in a sliding rod. It is usual to have one or two of these tuyeres shut off at a time, the time of remaining closed is predetermined, being usually about ten minutes.

By this method of operation, dull or bridged tuyeres are avoided, and the cupola is found to work both sweetly and efficiently. The advantage of this system will readily be realised, as by this equipment a very close and carefully-controlled condition of melting can be maintained. Whilst the height of the coke bed is greater than is usually the case, the recovery made after the drop compensates, to a great extent, for the extra coke used in this way.

By controlling the melting in this way it is comparatively easy to run at a 15 to 1 coke ratio even on small cupolas. Still better results are possible and are being obtained in many cases. The main advantages gained are:—(1) Coke saving, 25 to 40 per cent.; (2) ease of manipulation of the cupola; (3) maintenance of high temperatures; and (4) metal being produced free from oxidation, is consequently followed by a reduction in the number of defective castings. This is due in a large measure to the metal lying quiet, both in the ladle and in the mould.

In actual practice there is a noticeable absence of defects usually attributed to gases, etc., in the metal. The cost of outlay, in a case under the author's notice, is being recovered in a period of nine months by the saving effected. In some cases the period has been even shorter. It should be noted in passing that existing plant may usually be converted to the balanced-blast type with ease, the main cost being the tuyeres, supplemented by a single payment to the Association as a licence, which is based on the hourly rate of melting.

A few figures (Table I) may be of interest regarding a small installation now in operation. These particular cupolas were put down to provide metal for small castings, pipe bends, etc., the metal often being poured into shanks from the one-ton ladles usually in use.

As with the old type of cupolas it was thought that 2½ cwts. of coke per ton would be required; it will be seen that the estimated saving of 25 per cent. has been met, although the cupolas

TABLE I.—*Data from Balanced Blast Cupolas.*

Internal dia. of cupolas	33 in.
Number of main tuyeres	6
,, of rows of auxiliary tuyeres	3
,, of auxiliary tuyeres per row	6
Weight of iron per charge (pig and scrap)	15 cwts.
,, coke per charge ..	112 lbs.
,, limestone per charge ..	35 lbs.
,, bed coke per charge ..	13 cwts.
,, metal melted per day ..	25 tons.
Coke recovered from drop	5 cwts.
Melting rate of cupolas	4½ tons per hr.
Blast pressure	9 ozs.
Average temperature at spout ..	1,360 deg. C.
Coke used per ton including bed ..	1.91 cwts.
Coke used per ton including bed and deducting recovered coke ..	1.72 cwts.
Coke used per ton excluding bed ..	1.40 cwts.

are small and are running under difficult conditions. The figures quoted include six heavier charges of coke which are used to overcome lengthy stoppages and thick cupola lining.

Secondary Tuyeres.

Secondary tuyeres have been the subject of much discussion at one time or another. A few observations by some well-known authorities may be of interest.

(1) Prof. F. C. Thompson and Dr. L. Becker, in the Institute Paper of 1926, quoting from a Paper by Porter, were in perfect agreement with him when he said: "A second row of tuyeres is supposed to effect the more complete combustion of the carbon by the addition of oxygen at a point where it can burn the carbon monoxide. Theoretically this appears to be an excellent idea, but actually it usually fails to accomplish the desired result."

(2) Another well-known authority also said some time ago "That auxiliary tuyeres were not, in a properly-designed cupola, of advantage," and that the "theory of thermal economy by injection of secondary air through auxiliary tuyeres rest on a fallacious basis."

(3) Even the late Dr. Moldenke, in his "Principles of Iron Founding," page 424, was rather sceptical when he said: "The idea of the upper tuyere was originally the furnishing of additional air to burn up any carbon monoxide present in the melting zone and thus get the full calorific value of the fuel. Theoretically fine, but practically imperfect of operation."

When knowledge was more limited than it is to-day, many people believed the earth to be a flat disc. As knowledge increased, scientific observers were able to prove that the earth was a globe. The balanced-blast cupola is the outcome of progress in knowledge in a similar way. The adjustment of air on individual tuyeres is unlike any other method in that it enables combustion to take place at a definite melting zone. Failure of previous efforts to burn carbon monoxide by upper tuyeres has arisen from the omission to limit the air at the bottom row of tuyeres. That the method is efficient can be seen by anyone having the opportunity of examining the gases at the charging door whilst the cupola is operating. No flames can be seen and the gases are cool.

In rapid melting of this type the iron absorbs heat during its descent, whilst the coke reaches the melting zone in an unimpaired condition. Secondary tuyeres in the past were inserted high up in the cupola in many cases, and whilst promoting the combustion of the carbon monoxide to some extent, they raised the temperature of the coke. Since carbon dioxide absorbs carbon at high temperatures with the formation of carbon monoxide, a reaction commencing at about 400 deg. C., some of the coke was used before arriving at the melting zone.

Mechanical Charging.

Before passing to other matters concerned with the practice of cupola control, two methods of mechanical charging have given good results over a considerable period. The first method relates to a top-charging bucket and cone arrangement based on a German furnace-charging idea. The bucket is placed on a special seating on the top of the cupola, whilst the operator lowers the cone, which is attached to a centre stalk, causing the material to discharge into the enlarged part of the cupola, which is lined with iron bricks.

A second method is a rather novel side-charging arrangement. Here the tray, which normally rests on a weighing machine, is lifted at one end by means of a compressed-air hoist, and the charge is tilted into the cupola. Distribution of the charge is ensured by means of a metal guide permanently fixed at the edge and in the centre of the tray, dividing the charge as it slips forward into the cupola.

General Cupola Practice.

It is not proposed to give a list of do's and don'ts regarding cupola manipulation. The cupola is much like the human body in many ways: if it is fed uniformly and regularly, with good material of uniform size, it will function properly, other things being equal. Sufficient has been said to show how all-important air control is, but this is mainly in the hands of the designer, being supplemented by smaller adjustments under the control of the operator.

Cupola Linings.

One other matter in relation to cupola design may be mentioned, namely, the shape of linings. There is little doubt that the semi-boshed type is the best. In actual practice it has been found that a straight-lined melting zone gives good results; the straight part should extend past the lower tuyeres a distance of one to two diameters. In the case of high-speed melting the original dimensions of the cupola must be strictly adhered to; failure to comply with this will mean either losses in economy of fuel and temperature, or bad working conditions by the bridging or blocking of tuyeres. The semi-boshed type enables the inert gases to pass away from the melting zone, and up the shaft with reduced velocity, the sensible heat being more readily absorbed by the descending charges.

Rammed Linings.

The author is firmly convinced that, except in a very few special cases, the rammed lining is the best for modern practice. With the higher-melting temperatures demanded for higher-quality irons, together with rapid melting, the attack on the lining is severe, and thus a highly-refractory and uniform lining at the melting zone is required. Where cupolas are only operated for a short time, the type of material used is not so important. Repairs are made more easily, and slightly cheaper material may be used with but little loss in efficiency. Many rammed linings have failed because proper care has not been taken in their installation. The most potent causes of failure which come to mind are: ramming in the material too wet, lack of preliminary drying and the use of material low in refractory properties.

The material, if of fairly fine grade, should contain about 7 to 8 per cent. moisture when used for ramming purposes, as distinct from repairing materials which contain from 12 to 15 per cent. Moisture in materials of this type should be carefully controlled, as greater amounts than those stated may give rise to poor results in melting.

Slag Control.

The subject of cupola refractories was ably dealt with by Dr. Skerl recently, but a few remarks in regard to slag may not be out of place. There has been disclosed the analyses of bad, average and good slags, but obtaining the desired composition is another matter. On the authority of Mr. J. E. Fletcher, desulphurisation is negligible with cupola slags containing less than 30 per cent. of lime. Experience shows

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that good practice can be maintained by running at just below this figure, desulphurisation being obtainable by other methods when and where required. Cupola slag should be able to flow easily from the slag notch, thus facilitating cupola operation.

The constituents of slag, other than lime, are gathered from the coke ash, from the silica or sand on the pig-iron, from dirt charged with the scrap, from the breaking down of the refractories used in the lining, from the impurities in the limestone itself and by oxidation of the metal and its constituents. Where the refractories are poor, it becomes impossible to control the slag within fine limits. Take the case of a cupola using 50 lbs. of ganister per ton of metal melted, a not uncommon figure.

Assuming that 15 per cent. of this is water, a net weight of 42½ lbs. of lining material remains to be fluxed. For this purpose alone just over 34 lbs. of limestone of 95 per cent. purity will be required. The importance of care in the choice of materials which yield the smallest amount of slag cannot be too greatly emphasised. It is almost impossible to control cupola slag where the refractory materials are of low quality. Where coke is being reduced to a minimum the advantages gained are lost by using inferior materials of any nature in the cupola. For example, using a coke of high ash content not only increases the amount of slag formed, but efficiency is again reduced by the lowering of available carbon.

In most cases it will be found that improved results warrant the somewhat higher prices demanded for the materials. Obviously each founder has to consider his own case and decide for himself, but the purchase of very cheap material is seldom profitable.

Metal Purification.

The industry is confronted with more indirect problems in cupola practice to-day by the many *methods of metal purification* which are being used. The choice of good material with high-temperature melting at least reduces the need for the application of such methods. There is little doubt that when cupola metal is tapped at a high temperature and allowed to cool until a correct pouring temperature is reached, the best results are obtained. Some of the methods of improving metal include the addition of briquettes to the cupola, desulphurisation of metal in receiver or ladle, and additions of ferro-silicon and calcium silicide and the like, to refine the metal.

Many of these operations are accompanied by the use of special methods of pouring the metal, and some patent cupola processes undoubtedly depend to a great degree upon them, for improvements in the metal which are claimed. The melting of high percentages of steel scrap together with the use of common iron scrap has rendered metal purification more necessary. Many founders in the past have been slow to realise the value of clean metal, but are now becoming alive to the advantages to be gained by using care in the preparation for teeming.

The value of cupola control is not found simply in the economies which can be translated into £ s. d. It may be seen by the quality and regularity of the finished product coupled with a smooth-running unit, which enables the maximum production of the shop to be met. Time is never wasted in using care to obtain hot, good, clean metal. The use of the most elaborate methods of skimming and pouring are often fully justified, ensuring as it does the arrival at the mould, of metal in good condition. Having seen the conveyance of the metal to the mould in this condition it remains the duty of the mould to set a seal to its perfection in the production of a good casting.

The author has endeavoured to show in this Paper a little of the direction of progress in cupola control. It is a well-beaten track but much remains to be done. As in every other science, advances will continually be made, and although one often fails to reach the high standards desired, one has to remember that the failures of to-day are but the stepping stones of to-morrow's success.

The author acknowledges with thanks the permission of the Staveley Coal & Iron Company, Limited, to use certain of the matter in this Paper. He is grateful for the encouragement received from Mr. J. B. Allan (Foundry General Manager) and Mr. J. G. Pearce—Director of the British Cast-Iron Research Association.

Steel Grating for Road Construction.

Tests with a new type of steel roadway have been conducted in Germany, according to a recent issue of "Stahl und Eisen." The surface is constructed of steel units, consisting of bars of flat or angle iron, 80 by 5 mm. in section, on which short flats, 26 by 3 mm. in section, bent to an angle of 120 deg., are welded edgewise at the bend. These units are laid on a suitable ballast and welded together to form a zig-zag grating, which is filled with gravel or bituminous material to a level of 1 cm. above the top edge of the grating. The surfacing above the grating is rammed down by traffic in a short time, and forms a hard, slightly undulating surface with troughs up to 3 mm. in depth. Measurements on an experimental stretch of roadway showed that the distribution of moving loads is more even than on surfaces constructed with straight bars running the length of the highway. Restitution of the surface after the passage of heavy vehicles was found to be complete. The surface is claimed to offer a minimum of drag, to be sufficiently hard to prevent the formation of potholes and ruts, to have a minimum wear and prevent skidding, besides being cheap to lay down. It is calculated that the costs of construction amount to 7 Rmk. per sq. m., as compared with 12 to 15 Rmk. for various asphalte surfaces, 9 Rmk. for tar-macadam, and 14 to 20 Rmk. for granite blocks. The steel requirements vary from 15 to 30 kgs. per sq. m., and as an additional precaution against corrosion, special steel containing a small proportion of copper should be used. A road of this class is estimated to last from 15 to 20 years without costly maintenance.

Continental Steel Cartel.

In principle the Continental Steel Cartel has been renewed for a period of five years as a result of the deliberations of the chairmen of the national groups in Brussels on February 3. The terms of the agreement only come into force after the Forges de Clabecq has joined the Belgian group. The first half of 1932 has been chosen as a basis for calculating the quotas of each group. Various subsidiary questions were discussed at Luxemburg on February 11, while negotiations concerning international selling syndicates for individual products took place in Brussels on February 9.

Heats of Formation in Metallurgical Reactions.—The very large amount of work being done on the heats of formation in reactions of importance in the manufacture and treatment of iron and steel is reflected in the table of these given by Dr. Carl Schwarz in Report No. 240 of the Steelworks Committee of the Association of German Ironmasters, published in "Archiv für das Eisenhüttenwesen" recently. This gives the most probable values in the light of present knowledge, and it is noted that in the majority of cases the figures given differ from those published as recently as 1927, although in others the values are quoted from the 1913 German edition of Prof. Richards' well-known book on metallurgical calculations. A number of values, supplied by Prof. W. A. Roth, have not been previously published. The heats of formation of nitrides are now included in the table.

A New Foundry Ramming Machine.

To meet the demands of a large number of founders, the British Moulding Machine Company, Limited, have recently placed on the market a new type of machine known as the "Easiram." This machine, illustrated in Fig. 1, can be fastened to a wall or stanchion over benches, troughs, hand-ram machines or plain-jolters. There are a vast number of smallish castings now being made in small quantities, and this machine enables these castings to be manufactured much more cheaply than when made by hand ramming.

The machine consists of a bracket with holes drilled to suit the individual requirements of the founders. Operating in this bracket is a swinging presser head which swings clear of the mould when drawing the patterns and lifting off the top half, etc. The ramming of the mould

Fig. 1.—The "Easiram" Mould Ramming Machine.

is done by merely pulling the lever forward and downward, and an adjusting wheel is fitted for regulating the head to the varying depths of boxes. There has been a great demand for this machine, and the manufacturers extend a cordial invitation to all founders to inspect it in operation, in the demonstration shop of their works at 237, Weston Street, London, S.E.1.

Nickel-Aluminium Steels for Permanent Magnets.—A recent issue of "Stahl und Eisen" discusses the investigations of T. Mishima on magnetic steels. It was found that steels containing 10 to 40 per cent. Ni and 1 to 20 per cent. Al are particularly suitable for making permanent magnets, as they possess a greater remanence and coercivity than ordinary tungsten and cobalt steels. The coercivity of a steel containing 25 per cent. Ni and 10 per cent. Al is 650 Gauss, *i.e.*, nine times as great as that of ordinary tungsten steel and 2½ times that of cobalt magnetic steel. The coercivity and remanence vary with the chemical composition. Compared with ordinary magnetic steels, another advantage of the Ni-Al steel is that the coercivity and remanence vary only very slightly with the temperature up to about 700 deg. and are unaffected by sudden shocks. A disadvantage of these steels is, however, their lack of ductility and malleability, and they can only be cast, which considerably reduces their field of application.

Alloy Cast Irons in Automobile Construction.*

By A. B. Everest, Ph.D.

For a variety of reasons, cast iron is to-day accepted as the standard material for such important parts in automobile construction as the cylinder block, head and liners, for brake drums and for a number of less important or smaller components, such as pistons, valve seats and guides, tappets and turning wheels. In almost every one of these applications the demands of the automobile engineer are so severe that one or other special grade of iron has been adopted by the foundryman.

Interest in alloy cast irons in this field was first aroused about five or seven years ago, when changes in engine design and more exacting service demands brought such problems as cylinder wear into prominence. Since that time continuous endeavours have been made to obtain irons which will meet the most rigorous demands of both the manufacturer and user. The use of alloy additions in the irons is one of the methods which has received extensive attention, and has been in many cases adopted, and, in this Paper, an attempt is made to review the progress effected during these years and to examine the present position in this special branch metallurgical engineering.

The development of the compression ignition engine and its application to road transport is again closely tied up with developments in iron castings, since the conditions of running are, in many respects, more severe even than found in the modern petrol engine.

Cylinder Block Castings.

In the earlier days of automobile engineering cylinder-block design was often bad from the foundry point of view. Little attention was given to the metal employed, however, provided that the casting was water-tight and reasonably machinable, Once the casting was in service, little further trouble was experienced, owing to the fact that running conditions were so light, as compared with those of to-day, that rapid wear was unknown, and, furthermore, the total mileage run by the vehicle was only a fraction of that demanded of even the cheapest makes to-day.

A soft cast iron, running under light conditions, will often form a hard glazed surface which will show better life than a harder iron might have done under the same conditions. For example, a soft iron will often give excellent service in large steam- or gas-engine cylinders, and engineers still speak of the mirror-like surface such cylinders will show after being "run in." The high phosphorus content which was no doubt used in the iron would add further to its wearing quality.

For these various reasons cylinder castings did not give much trouble in service until the present era was commenced. Engine evolution, not uninfluenced by the fiscal policy of the Government, and increased efficiency in the other parts of the car, led to the adoption of the high-speed, high-compression, long-life engine of to-day, and cylinder wear became one of the biggest running problems. The softer self-glazing cast irons were no longer suitable, as the conditions did not now permit the formation of a glaze, and such irons, moreover, proved deficient in mechanical strength. Engineers and foundrymen therefore co-operated in the direction of maintaining a hard, dense structure in the cylinder bores, in the belief that such structures would give the best resistance to abrasive wear.

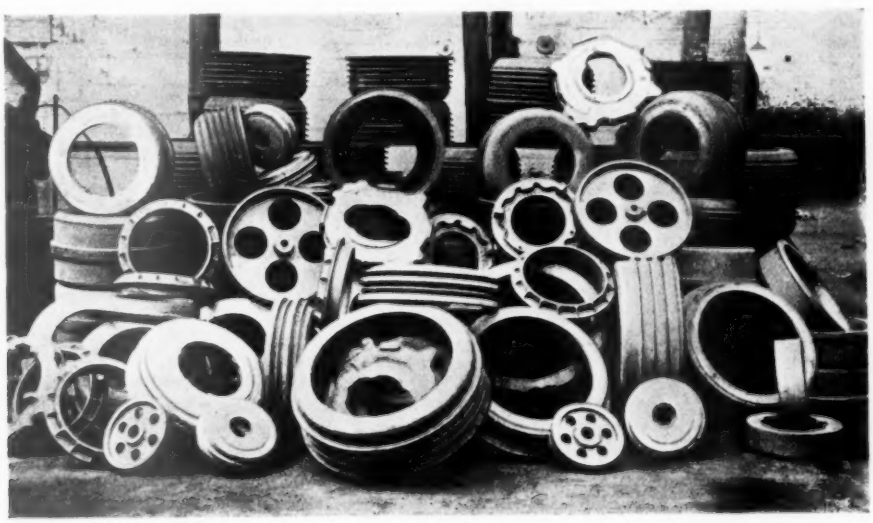

FIG. 1.—GROUP OF NICKEL CAST-IRON CASTINGS, SHOWING SOME OF THE MANY TYPES OF BRAKE DRUMS, CLUTCH PLATES AND PRESSURE PLATES MADE IN "MILLENITE." (By courtesy of Lake & Elliot, Limited.)

The maintenance of higher hardness in cylinder castings, however, is a difficult problem from the foundry point of view, principally on account of the complexity of the average cylinder-block casting, and especially the wide variation in section thickness which it involves.

It is a matter of common knowledge that the quickly-cooled metal in thin sections is harder than the more slowly cooled material in thicker parts, or in the inner portions of the casting, yet in a cylinder-block, the machinist first demands ready machinability in the outer thin sections and at corners and edges, whilst the ultimate service given by the engine depends on a dense, hard structure in the cylinder bore. A moment's thought reveals that these demands are contradictory, and, in the past, it has been the quality of the cylinder-bore metal which has generally been sacrificed for the ready machinability on the outer parts of the casting.

Alloy cast irons first became of interest, therefore, on account of the control of the metal which they offered, especially in equalising the structure between the thick and thin sections, for by such equalisation it is clear that cylinder hardness may be increased, whilst maintaining machinability throughout. The special alloys now added to cast iron include nickel-chromium and, to a small degree, molybdenum, copper and aluminium.

The effect of nickel is to soften chilled cast iron, that is to say, iron which shows a white or mottled structure due to quick cooling whilst, at the same time, it maintains the hardness of thicker sections, refining the grain and adding to strength and ductility. Chromium, on the other hand, acts in a direction opposite to that of nickel, in that it increases the proportion of white iron in the thinner sections, and consequently increases machining difficulty, unless special precautions are taken; strength and density are again, however, increased.

The equalisation of structure effected by nickel is perhaps best illustrated by a definite example of a cylinder block. A certain heavy block was ordered to a specification calling for a Brinell hardness of 200 minimum in the cylinder walls. The casting in question had cylinder walls which were $\frac{5}{8}$ in. thick "as cast," whilst the water jacket on the outside of the casting was $\frac{3}{8}$ in. thick in places. With the usual variation of structure, which occurs in cast iron, it was found that ordinary mixtures of iron which would give a cylinder hardness even approaching that required, gave castings which were quite useless on account of the fact that they were hard and unmachinable on the outer faces. With the use of an iron such as above, with an addition of about 1 or $1\frac{1}{2}$ per cent. of nickel, it became possible to make the casting under ordinary foundry conditions, so that it was not only readily machinable on all faces, but this was coupled with a Brinell hardness in the bore of 215.

Nickel is also of interest in cases where trouble with porosity and leakage is encountered. Due to the greater density and finer grain obtained with nickel, troubles caused by leakage in cylinder blocks and heads on pressure tests are greatly minimised. This, of course, aids both the foundryman in testing his finished castings, and also the production engineer when, after machining, hidden defects are liable to be found in ordinary cast iron. Owing to its influence in increasing chill under ordinary conditions, chromium cannot, of itself, be used to give an iron greater latitude as in the case of nickel, and it is for this reason that many manufacturers have, in the past few years, adopted alloy cast iron generally containing 1 to $1\frac{1}{2}$ per cent. of nickel primarily from the point of view of ensuring for themselves trouble-free production.

The Elimination of Cylinder Wear.

Of wide interest is the question of cylinder wear and the influence which alloy cast irons may have on this problem. Unfortunately, it is not possible at the present time to submit any definite figures. Cylinder wear is the result of a combination of circumstances which vary not only from one make of car to another, but also vary with individual drivers. The influences most affecting cylinder wear are generally considered to be questions such as lubrication, the sympathetic driving of the engine, that is to say, not overloading the engine when it is cold, or racing it to warm it up and, to a large extent, the materials used for the piston and piston rings and the condition of both piston and rings. If anything, the materials from which the cylinders are made appear to be relatively of minor importance, if one can judge anything from service reports available. Quite ordinary cast irons which would normally be expected only to show 2,000 or 3,000 miles per thousandth of an inch wear, sometimes yield figures as high as 20,000 miles, whilst special cast irons, expected to

* A Paper presented before the Institution of Automobile Engineers.

show appreciable improvements, often fall within the same range, so that it becomes extremely difficult to draw any definite conclusion, and individual results are meaningless.

It is generally accepted that, with good fitting pistons and piston rings, and with the maintenance of good lubrication, cylinder wear, even with quite poor-quality irons, would almost disappear. These ideal conditions of running are, however, rarely if ever encountered, and the problem therefore resolves itself into one of finding a metal which will resist abuse to the greatest possible degree.

A study of a worn cylinder reveals the fact that cylinder wear is always at a maximum at the top of the piston-ring stroke. This would suggest that cylinder wear is due to actual penetration of the piston ring into the cylinder wall, probably under the influence of the explosion pressure actually getting behind the ring and driving it outwards. It was therefore logical to assume that, from the metallurgical point of view, cylinder wear could be combated by the use of denser and harder grades of metal. In meeting this requirement nickel and chromium, separately or together, have been used, whilst, to a lesser extent, other alloy elements such as molybdenum have been added to cast iron.

The conclusion of the past few years' experience with these special irons seems to be at the moment that, provided a reasonable density and hardness is maintained in the metal, the actual presence of one or other alloy element is of relatively little influence. When nickel is used to aid production it has only an indirect effect in improving wearing quality, by enabling dense and strong metal to be obtained in the cylinder bore. Chromium was thought at one time to offer better hopes in combating wear, but recent experience does not seem to indicate that any very material advantage is derived from this element. Moreover, for production reasons, chromium is not generally applicable unless accompanied at the same time by a proportion of nickel. Several manufacturers report improved wearing quality from a nickel-chromium grade of iron, but here again it has been difficult to obtain any very conclusive figures. A study of a large number of service reports does, however, seem to show that 25 to 30 per cent. improvement in life is generally obtained with the alloyed iron.

Fig. 2.—Nickel Cast-Iron Valve Guides, some of which have been Hardened by Heat-Treatment. (By courtesy of Seal-Tite Piston Ring Company, Limited.)

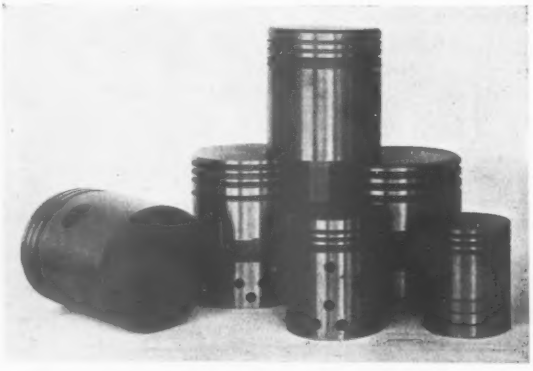

Fig. 3.—Nickel Cast-Iron Automobile Pistons. (By courtesy of Seal-Tite Piston Ring Company, Limited.)

Cylinder Liners.

The use of cylinder liners has, perhaps, offered the most helpful contribution towards combating cylinder wear, for, in a liner casting, no trouble is experienced with varying section and, from the point of view of design, the casting is as simple as could be desired. This means that the loose cylinder liner casting can be made of metal whose composition is controlled to give the best possible results for the user without any restrictions encountered in manufacture.

Liners lend themselves to special methods of casting, as, for example, by the centrifugal process, whilst, at the same time, they offer opportunities for the best results to be obtained from the use of alloy additions in the iron, especially when the castings are subject to subsequent hardening by heat-treatment, or such a process as nitrogen-hardening.

Nickel and chromium separately or together are repeatedly used in liner castings to-day and, exactly as in the case of cylinder blocks, it is found that nickel tends to aid machining whilst maintaining a fine-grained, dense structure in the metal, whereas chromium increases hardness and strength, but, by itself, tends to introduce trouble with machining.

Experience on the road has, however, as in the case of block castings, again failed to show any striking improvement in wearing quality resulting from the use of small additions of these elements to the iron.

Heat-Treated Cast-Iron Liners.

In the above discussion the use of only small proportions of nickel and chromium, which are necessary to refine and densen the ordinary iron structure, are considered. It has been realised that cast iron, like steel, can be hardened by heat-treatment, the structure of the metal being turned from the ordinary pearlitic structure common to cast irons and medium-carbon steels, into the martensitic structure, which is the basis or hardened-tool steel. Since, in the case of steels, the hard-martensitic structure is used regularly for such parts as cutting tools, where, of course, wear is a vital factor, it is a logical conclusion that the martensitic structure, if it could be applied to the problem of cylinder wear, might be of commercial interest.

Until recently, however, the process of heat-treatment has not been generally applied to cast iron, due principally to the fact that experience has shown that the heating and quenching of a piece of cast iron generally results in fracture of the casting. The increased use of alloy cast irons has, however, now brought about a change in thought on this matter.

In the case of steels, it has been recognised for some time past that nickel has the effect of both lowering the temperature from which quenching must be effected in order to increase hardness and, also, of lowering the critical speed of quenching, so that a lower-cooling rate will produce the desired result. Chromium, at the same time, is useful on account of its action in stabilising the structure of the metal.

Experiments on the heat-treatment of alloy cast irons have revealed that a similar argument holds, as in the case of steel, and that by the use of nickel both the critical temperature and the critical speed of cooling are reduced so that, whereas an ordinary cast iron would have to be quenched in water from a temperature of about 850 deg. C. in order to obtain the desired hardening, with a nickel cast iron a lower initial temperature can be employed, and the cooling can be carried out even in an air blast. The effect of nickel can be carried further so that, with about 5 per cent., the critical cooling speed is so slow that, with thin-sectioned castings, it corresponds with the speed of cooling of the casting, and the iron becomes martensitic "as cast."

In considering, therefore, the possibility of adapting the martensitic structure of cast iron to castings such as cylinder liners, two methods are available. Firstly, an iron with 5 to 6 per cent. of nickel may be employed which will give a casting which, while fully grey, is yet tough and very hard, showing a Brinell hardness generally approaching 400. This casting can be machined with care, using a Widea tool, and, after grinding, can be put into service in the normal manner. As an alternative, a lower proportion of alloy additions can be used, and, after machining, the casting can be heat-treated so as to develop the martensitic structure. The heat-treatment in the presence of the alloys may consist in quenching in oil, or in an air blast, according to the section thickness of the casting. The quenching may, generally with advantage, be followed by a tempering treatment which restores any mechanical strength which may have been lost in the actual quenching operation.

Given that the martensitic type of liner has become commercially available, automobile engineers naturally watched this material with interest in tests on the road. The conclusion among its users and manufacturers seems to be fairly unanimous that the martensitic type of cast iron does definitely offer advantages in combating the problem of wear. Most reports show that, with the martensitic type of iron produced by heat-treatment, an improvement in life approaching 100 per cent. is generally obtained. Even greater improvements are reported for the higher alloy iron, which is martensitic as cast.

In referring to the relationship between alloy additions and heat-treatment, it is perhaps desirable to make it clear that the martensitic structure is a function primarily of cooling rate. Clearly a thin-section casting can be cooled throughout more rapidly than can a thicker-section casting, so that, with a thin-section liner, it is easier to maintain a fast cooling rate and so maintain a martensitic structure, than in the case of a heavier casting.

Experience has shown that, in the case of thin cylinder liners, the amount of nickel may be very appreciably reduced, and it is, in fact, sometimes less than 1 per cent. when larger castings have to be heat-treated, however, as, for example, in the wet liners now coming into favour in Diesel engines; then the problem becomes more severe, and, if a high quenching rate were maintained, distortion and cracking would probably result. It is under these conditions that nickel is of the greatest benefit in order artificially to lower the critical speed of cooling, and so obtain depth of penetration of the hardening effect, with consequent elimination of distortion.

(To be continued.)

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This Week's News in Brief.

Trade Talk.

The dismantling of the shipyard at Campbeltown has been commenced. The plant is to be broken up and the site cleared. The yard, which belongs to the Campbeltown Shipbuilding Company, Limited, has been idle for several years.

The Council of the Institute of Metals has accepted an invitation from the Committee of the Institute's Birmingham Local Section to hold the Silver Jubilee Meeting of the Institute in Birmingham from Monday, September 18, to Thursday, September 21.

Exercising an option obtained when they ordered a similar vessel last month from the same builders, Messrs. H. Hogarth & Sons, Limited, Glasgow, have placed an order with Messrs. D. & W. Henderson, Limited, Meadowside, Partick, Glasgow, for a cargo steamer of 6,500 tons deadweight.

Messrs. N. Hingley & Sons, Limited, Old Hill Iron Works, Staffs, will start operations again in April after being idle since September last. The rolling mill at the works is being reconditioned. The forge will be restarted in its old form, with the reconditioned mill. The original plant was laid down in 1882 by the late Sir Benjamin Hingley.

Launched by Messrs. William Denny & Bros., Limited, from their Leven Yard, Dumbarton, in December, the turbine steamer "Brighton," which has been built to the order of the Southern Railway Company, has commenced trials on the Clyde. The vessel, which is for service on the Newhaven-Dieppe route, is designed for a speed of 24 knots.

Eight men received burning injuries in a Glasgow foundry accident on Monday when molten metal, which filled a 2-ton ladle, poured on to the floor. The accident happened in the premises of Messrs. James Howden & Company, Limited, engineers, 195, Scotland Street, and one of the injured men is Mr. H. Ulander, of London, a director of the company.

Messrs. Lithgows, Limited, Port Glasgow, have been allocated a tramp steamer of about 7,000 tons, of a design by Sir Joseph Isherwood. It has already been proved that the new design will show considerable economies in operation. The cubic capacity of the holds will be 3 to 5 per cent. greater than the best of post-war-built ships, whilst the fuel (coal or oil) consumption will be 10 to 15 per cent. less.

The Central Wagon Company, Limited, of Wigan, have now bought the whole of the share-holding in the Ince Waggon & Ironworks Company, Limited. The Ince Company was registered in 1883 and was in existence before that time as a private concern. With the falling-off in wagon building its interests have been centred more in other departments, and an entirely new foundry has been erected and equipped with the latest machinery.

Messrs. Sir W. G. Armstrong Whitworth & Company (Engineers), Limited, Newcastle-upon-Tyne, have secured a contract for the construction of a complete Diesel-electric express train for the San Paulo Railway of Brazil. This is believed to be the first complete oil-electric train ever to be built by one firm alone. Messrs. Armstrong Whitworth are also shipping to South America this month three power units for similar oil-electric trains.

The Frodingham Iron and Steel Company, Limited, has restarted a blast furnace which had been closed down for repairs since before Christmas. There are now two furnaces operating at the Frodingham Company's works, and two at the works of the Appleby Iron Company, Limited. With the addition of furnaces operating at the Normanby Park Steelworks, there are now seven blast furnaces working in the Scunthorpe district, out of a total of nineteen built.

At a recent meeting of the Osaka Iron and Steel Merchants' Association, the question of a further revision of the import tariffs on iron and steel proposed by the Osaka Chamber of Commerce and Industry was discussed. It was decided that a reduction in the duties was desirable, owing to the marked changes which had taken place in the Japanese iron and steel trade since the last revision of the duties. It was also pointed out that foreign competition was adequately restricted by the fall in the exchange.

Orders for over two and a-half million pounds worth of naval work have been secured by Clyde firms under the 1932 Admiralty programme. Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, have the order for the hull and machinery of the cruiser H.M.S. "Galatea"; Messrs. Beardmore & Company, Limited, Dalmuir, have the machinery for the cruiser "Apollo," to be built at Devonport; Messrs. Yarrow & Company, Limited, Scotstoun, hull and machinery of the flotilla leader H.M.S. "Fauldnor"; and Messrs. John Brown & Company, Limited, Clydebank, have the hulls and machinery of two destroyers.

An interesting brochure, covering 50 years of Glasgow's industrial progress, has been issued by Messrs. Watson, Laidlaw & Company, Limited, engineers and ironfounders, Glasgow, who celebrate their jubilee this year. The firm was established in 1882 by the late Mr. John Laidlaw and Sir William Renny Watson. Mr. Laidlaw had served for some years with the firm of Mirrlees, Tait & Watson, sugar machinery engineers, Glasgow. In the year of commencement the firm obtained the sole manufacturing rights for Britain for the Weston centrifugal machine, and since then have manufactured over 30,000 of these machines for use all over the world. The machines are used mainly in sugar factories and refineries, but also find applications in the chemical, textile laundry and other industries.

Personal.

Mr. William G. Gray has retired from the position of chief statistician to the American Iron and Steel Institute.

Mr. John B. Downing, iron and steel merchant, of Halesowen, was recently elected an Alderman of the Worcester County Council.

Mr. Francis Henderson has been elected Second Master of the Shipwrights' Company, of which the Duke of York is the permanent Master.

Mr. Headlam-Morley, hitherto in the employment of Messrs. Dorman, Long & Company, of Middlesbrough, has been appointed secretary of the Iron and Steel Institute.

Mr. Albert M. Portevin, the distinguished French engineer and President of the Société de Ingénieurs Civils de France, will deliver the Twenty-Third Annual May Lecture to the Institute of Metals on Wednesday, May 10. The subject of his Paper will be "Quenching and Tempering Phenomena in Alloys."

Dr. W. H. Hatfield, Director of Research in the firm of Messrs. Thos. Firth & John Brown, Limited, has been awarded the Bessemer Gold Medal for 1933 by the Council of the Iron and Steel Institute in recognition of his distinguished services in the advancement of metallurgical science, and of his valuable researches in connection therewith.

Mr. Horace J. Young, who last year was appointed to take charge of the foundry and research departments of Hepworth & Grandage, Limited, St. John's Works, Bradford, has now been elected a director. This company are makers on a large scale of pistons and piston rings, and are well known as being the only firm in this country making piston rings by the single-cast process. Mr. Young was for many years chief metallurgist to the North Eastern Marine Engineering Company, Limited, of Wallsend-on-Tyne and Sunderland. He is well known in foundry and scientific circles, both in this country and abroad, and has been the author of many Papers on cast-iron and foundry practice. His Paper "Corrosion by Oil," given before the Institution of Petroleum Technologists, attracted much attention, and gave rise to the now well-known D.O.C. (direct oil corrosion) Test. Prior to joining Messrs. Hepworth & Grandage, Mr. Young was in private consulting practice in London, and was called as expert witness on many important legal cases. He is an old member of the Institute of Marine Engineers, which body presented him with their silver medal. Also, he represented the North-East Coast Institution of Engineers and Shipbuilders on B.E.S.A. Committees. The earliest labours of the British Cast Iron Research Association formed one of his interests, and at that period he was President of the Newcastle Branch of the Institute of British Foundrymen, forming the first Junior Section there. He succeeded Prof. Louis as chairman of the Newcastle Branch of the Institute of Metals.

Wills.

Williams, John Frederick, lately chairman of Messrs. John Williams & Company (Wishaw), Limited, Excelsior Iron & Steel Works £57,338

Contracts Open.

Cairo, February 28.—Supply and laying of 1,500 m. of 12-in. and 1,500 m. of 6-in. cast-iron, steel or Armco sealed sewage and air main, for the Ministry of Public Works, Egyptian Government. The Department of Overseas Trade. (Reference G.X. 12,243.)

Chevening, etc., February 20.—2-in. to 5-in. cast- or spun-iron pipes, for the Sevenoaks Rural District Council. Messrs. H. Adams & Son, engineers, 60, Queen Victoria Street, London, E.C.4. (Fee £3, returnable.)

Dublin, February 22.—160 tons of structural steelwork, for the Great Southern Railways (Ireland). Mr. A. W. Bretland, chief engineer, Westland Row Station, Dublin, C.5. (Fee £2 2s., non-returnable.)

London, W., February 22.—Iron and steel stores, for the Hammersmith Borough Council. The Borough Engineer and Surveyor, Town Hall, Hammersmith, London, W.6.

London, W., February 17.—Railway axles, mild steel, copper rods, etc., for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1.

Salford, February 23.—Transformers, iron and steel stores, etc., for the Corporation. The City Electrical Engineer, Electricity Department, Frederick Road, Salford.

Sandwich.—Supply and laying of about 200 yds. of 3-in. cast-iron gas main. Mr. J. Giles, gas manager, Gasworks, Sandwich, Kent.

Southampton.—Centrifugal borehole and surface pumps, with Diesel engine, certain auxiliary plant, etc., for the Town Council. Mr. J. Hawksley, waterworks engineer, Civic Centre, Southampton. (Fee £3 3s., returnable.)

Widdington, February 21.—40 tons of 3-in. cast-iron pipes and specials, for the Saffron Walden Rural District Council. Messrs. Sands & Walker, Milton Chambers, Nottingham. (Fee £2 2s., returnable.)

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken

5,505. Dorman, Long & Company, Limited, and Wright, H. E. Alloy steel for structural purposes. 386,463.

14,360. Mond, A. L. (I. G. Farbenindustrie Akt.-Ges.). Method of extruding metal sections with progressively diminishing cross-section. 386,518.

24,318. Naamlooze Vennootschap Machinerieen-en Apparaten Fabriken. Welding machines. 386,596.

26,006. Porter, Inc., H. K. Portable bolt-cutting tools. 386,604.

23,737. Babcock & Wilcox, Limited. Furnace walls. 386,277.

20,239. Pollak, J. E. (Vereinigte Aluminium-Werke Akt.-Ges.). Production of cast-metal blocks. 386,247.

15,284. Stratmann, P. Press for bending and straightening iron parts, such as rails, beams, angle-irons, and the like. 386,210.

6,776. Koblitz, W. Improved iron sleeper having rail chairs consisting therewith of one piece, and method of its manufacture. 386,157.

6,836. Horst, Dr. H. Machines for casting metals. 386,159.

Obituary.

Mr. H. Wynne Roberts, director and sales manager of the General Electric Company, Limited, died on Saturday, February 4, at the age of 49. He had been prominently associated with the work of the British Electrical and Allied Manufacturers' Association and the Electrical Development Association.

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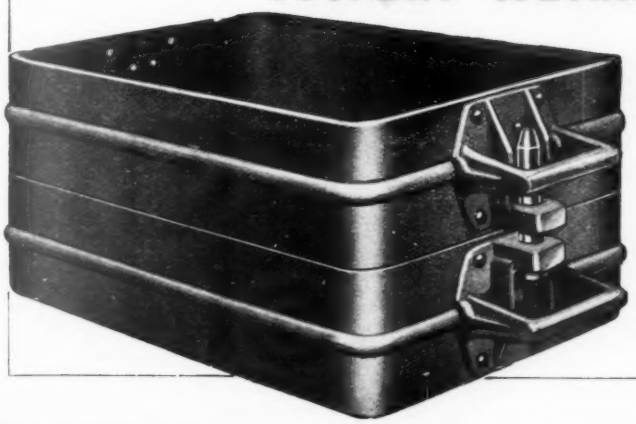

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Raw Material Markets.

A fairly steady tone is maintained in the iron and steel markets, but the demand still fails to show signs of any expansion. Stimulating factors during the past week have been the placing of additional shipbuilding orders and the favourable reports with regard to the efforts being made to revive the Continental Steel Cartel. Should these efforts be successful, both the Continental and British steel markets will considerably benefit from the elimination of "uneconomic" competition.

Pig-Iron.

MIDDLESBROUGH.—Trade is still restricted, although increased interest has been taken in the market. A few orders have been placed by local consumers, where absolutely necessary. Activity in the export market has fallen to a very low level indeed. Makers are strictly adhering to the new delivered zone quotations. In the Cleveland area the delivered price of No. 3 Cleveland G.M.B. foundry iron is 62s. 6d. per ton. Up to a line 50 miles west of Middlesbrough, and extending from the Scottish border to the Midlands, the delivered price is 64s. 6d., and beyond that point 69s. For No. 1 foundry or silicious iron a premium of 2s. 6d. per ton is charged, and there is a discount of 1s. per ton for No. 4 foundry and No. 4 forge. Scotland still enjoys a preferential rate, but the new quotation of 62s. 9d. per ton delivered Glasgow represents a considerable advance, which Scottish users are reluctant to pay.

Business is better in the East Coast hematite market. Consumers are endeavouring to use hematite wherever possible in place of the more costly foundry grade. In addition, increased sales have been made to the South Wales steelmakers. This improvement in the position has enabled several local works to reduce considerably their stocks of unsold hematite. Makers' quotations have not been increased, however, and remain at 59s. for mixed numbers and 59s. 6d. for No. 1 quality, although it is difficult to book far forward at these rates.

Messrs. Dorman, Long & Company, Limited, are modernising their basic-iron producing plant. As a preliminary step, a furnace is to be partly rebuilt at the Cleveland Works, South Bank, in order to increase its capacity from 200 to 400 tons per day. This size of unit has been decided on as being the most efficient for practical purposes.

LANCASHIRE.—The number of orders for foundry iron has increased slightly during the past week, and there has been an increase in the tonnage involved. Any large increase in the demand, however, is partly prevented by the presence of abundant and cheap supplies on the market of scrap iron, on which many foundries in this area rely for over 50 per cent. of their raw material. With regard to foundry-iron prices, these are maintained for delivery in the Manchester price zone, at 67s. per ton for Staffordshire and Derbyshire brands of No. 3, 65s. 6d. for Northamptonshire, 62s. for Derbyshire forge, around 82s. for Scottish foundry iron, about 75s. 6d. for East Coast hematite and 80s. 6d. for West Coast hematite. There is no evidence that supplies of North-East Coast iron are being pressed for sale in most parts of Lancashire, and quotations are therefore largely nominal at about the zone rates current for Derbyshire No. 3, which vary according to district. In Manchester, for example, they are on the basis of 67s. per ton, delivered, in Widnes 67s. 6d. and in St. Helens and Liverpool a maximum of 69s.

MIDLANDS.—The Midlands market for pig-iron is still very restricted. Activity is at a low level at both the light and heavy foundries, and it is difficult to envisage any immediate improvement. The furnaces are being compelled to add to their already large stocks. There has been no change in prices, the minimum zone rates delivered to Birmingham and Black Country stations being 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffs and Lincolnshire No. 3. Cleveland No. 3 is on offer at the Derbyshire level, *i.e.*, 66s., but Continental pig-iron is of no interest locally. For medium-phosphorus pig-iron, prices range from 70s. to 85s. 6d., with Scottish iron at between 83s. 6d. and 85s. 6d. There has been no change in the hematite market, any business from this district being for small lots. West Coast iron is controlled at 84s. 6d. delivered, but there is no control on Welsh or East Coast hematite and prices range, according to specification, from 75s. 6d. to 80s.

SCOTLAND.—Slightly increased buying has been noted from one or two directions, but a policy of hand-to-mouth buying generally prevails. A blast furnace has been changed from basic to hematite, but there are still only two furnaces in operation in this area, one on hematite and the other on foundry. Owing to an error in transcribing a Glasgow message, a rise of 2s. 6d. per ton in Scottish pig-iron prices was reported last week instead of a fall. The revised quotations are 65s. for No. 3 foundry, f.o.t. furnaces, with 2s. 6d. extra for No. 1 quality. No. 3 Middlesbrough is quoted at 62s. 9d. f.o.t. Glasgow and 59s. 9d. in the Falkirk area, Northamptonshire iron being about 2s. 3d. per ton less.

Coke.

Foundry coke remains a very quiet market, there being little or no forward buying. Quotations for best Durham coke vary from 36s. 6d. to 38s. per ton, Welsh grades being at 30s. to 45s., according to analysis, delivered Birmingham and district.

Steel.

The quiet appearance of the markets has been accentuated by the uncertainty resulting from the efforts which are being made to reconstruct the Continental Steel Cartel. Many of the Continental works have temporarily withdrawn from the market, and the general level of prices has been advanced several shillings. It is understood that negotiations are proceeding for the establishment of international sales offices, and overseas buyers are showing a strong inclination to withhold their orders until the outcome is definitely known. The home market has been less disturbed by the Continental position than the overseas trade, as it is some time since effective Continental competition has been experienced. Business, however, has been quiet. The demand for semi-finished steel has been poor, and consumers persist in a policy of buying from hand to mouth. Business in finished steel has been irregular, but there is still a fair demand for sheets on home and export account. In other departments buying has been light and principally for near delivery.

Scrap.

In the Cleveland scrap-iron market ordinary heavy cast iron is quoted at about 40s. per ton and machinery quality in handy sizes at 43s., but supplies are growing short. Light castings are at 37s. per ton. In the Midlands, consumption of scrap-iron has fallen away somewhat, but there is still a good demand for stocking purposes. Heavy machinery cast iron, broken into handy sizes, is offered at 47s. 6d. to 50s., good heavy metal at 45s. and clean light scrap at 40s., delivered works. In South Wales, heavy cast iron in large pieces and furnace sizes has been more active at 44s. to 45s. Good cast-iron machinery scrap is offered at 47s. 6d. to 50s. There is a slightly better demand in Scotland for heavy machinery cast-iron scrap at 47s. 6d. to 49s., and for ordinary cast iron at 45s. to 46s.

Metals.

Copper.—Largely owing to increased Japanese buying, the copper market strengthened considerably, but prices have now fallen to below the levels ruling a week ago. Quotations for electrolytic vary considerably, about 5.12½ cents per lb. c.i.f. Europe being the general level. The Japanese interest probably springs from a desire to provide for possible war requirements, and there is a possibility of the metal bought later being returned to the market. In addition, however, there has been a slight recovery in the demand from consumers, both here and on the Continent. This, however, is more attributable to periodical stock renewing than to any expansion in industrial activity.

Prices have been :—

Cash.—Thursday, £29 1s. 3d. to £29 2s. 6d.; Friday, £29 3s. 9d. to £29 5s.; Monday, £29 to £29 1s. 3d.; Tuesday, £28 11s. 3d. to £28 13s. 9d.; Wednesday, £28 5s. to £28 7s. 6d.

Three Months.—Thursday, £29 6s. 3d. to £29 7s. 6d.; Friday, £29 8s. 9d. to £29 10s.; Monday, £29 5s. to £29 6s. 3d.; Tuesday, £28 16s. 3d. to £28 17s. 6d.; Wednesday, £28 10s. to £28 12s. 6d.

Tin.—There has been little change in the market situation. A fair amount of tin continues to go into consumption in this country, particularly in the South Wales area. Prices are fluctuating within fairly narrow limits, market sentiment being fairly steady at the moment.

Prices of standard tin have been :—

Cash.—Thursday, £149 12s. 6d. to £149 15s.; Friday, £149 15s. to £149 17s. 6d.; Monday, £148 7s. 6d. to £148 10s.; Tuesday, £149 to £149 5s.; Wednesday, £148 10s. to £148 15s.

Three Months.—Thursday, £150 to £150 5s.; Friday, £150 to £150 2s. 6d.; Monday, £148 12s. 6d. to £148 17s. 6d.; Tuesday, £149 5s. to £149 7s. 6d.; Wednesday, £148 15s. to £148 17s. 6d.

Spelter.—There being no improvement in consumption, interest in this market largely centres on the efforts to prop up the International Zinc Cartel. A slightly more confident tone prevailed on the news that the producers had arranged to meet at Brussels, and it is hoped that an agreement may be arrived at. It is interesting to note that in the United States, where producers have abandoned the output-curtailment policy, the price of zinc has fallen to 2.65 cents per lb. East St. Louis.

Price fluctuations :—

Ordinary.—Thursday, £14; Friday, £14 5s.; Monday, £13 16s. 3d.; Tuesday, £13 16s. 3d.; Wednesday, £13 15s.

Lead.—During the past week increased interest was taken in this market, especially by speculative interests, but there were ample supplies on offer from producers. Many interests, however, are not too keen on selling at the low levels now ruling, so that the market manages to retain its balance.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £10 8s. 9d.; Friday, £10 8s. 9d.; Monday, £10 5s.; Tuesday, £10 5s.; Wednesday, £10 2s. 6d.

A Few Foundry Problems.

(*Concluded from page* 120.)

Mr. A. W. Walker, in confirmation, said he had been using steel in considerable quantities for many years, and he had consistently had a higher test from it than with ordinary cast iron.

The Chairman (Mr. Welford) said the statement had been made that semi-steel of the same analysis as a cast iron would be practically the same in result to all intents and purposes, and that was the crux of the question. The introduction of steel into the iron had given rise to the idea that the resultant mixture possessed all the properties of steel in the casting, but in actual fact that was not so. One may reduce the carbon, phosphorus and silicon by adding steel, but if one produced an iron reduced to 3 per cent. carbon instead of 3.5 per cent. one got more drawing. The great point was that of making a higher duty cast iron with half the expense.

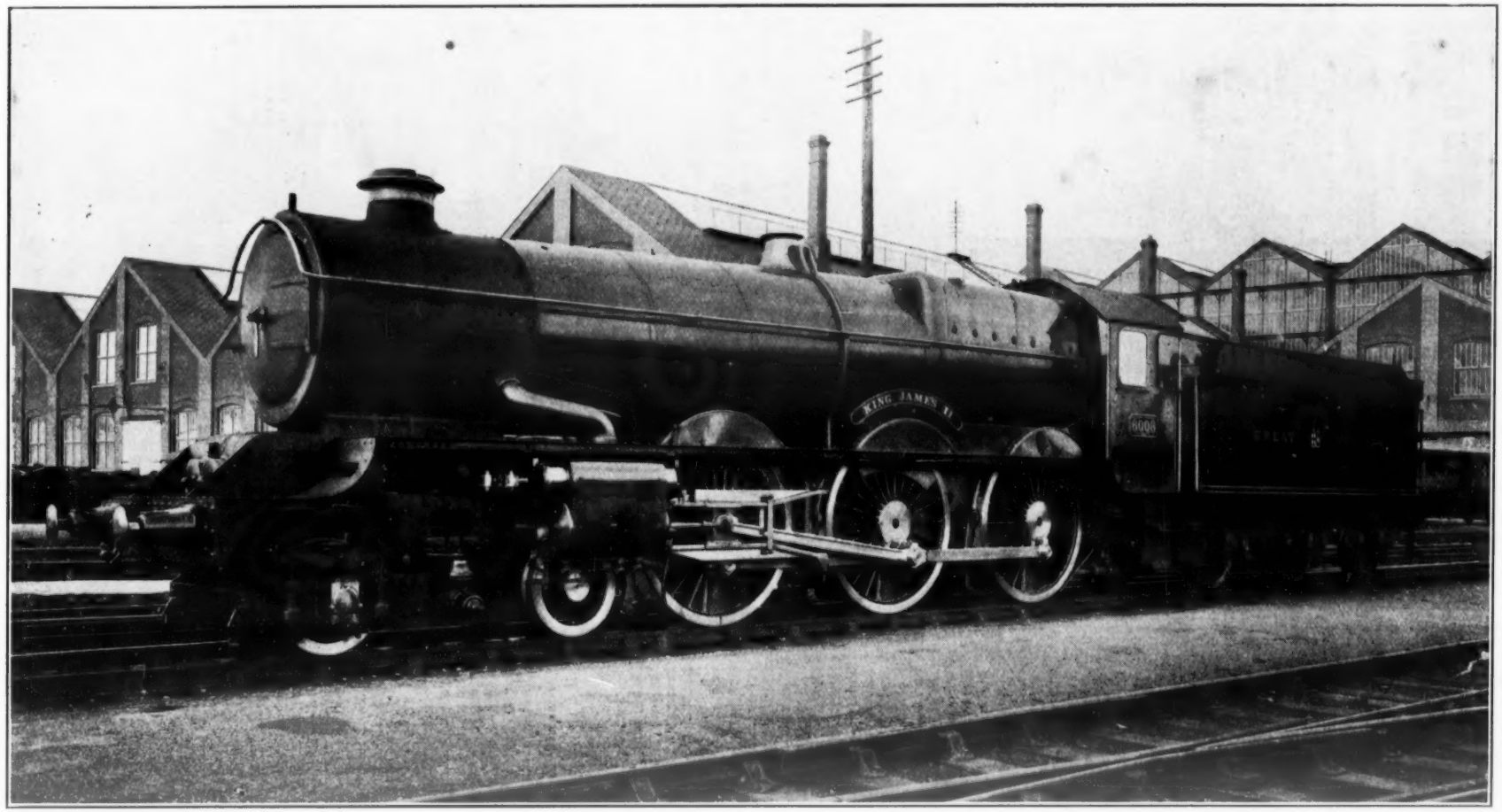
Hearty thanks were accorded Mr. Fearnside for his address, on the motion of Mr. W. Hawley, seconded by Mr. Carter.

Nota Bene.

The lecture on "Aluminium Castings" by Mr. F. H. Hurren, announced for February 20 in the programme of the Birmingham Branch, has been cancelled, and in its place Mr. W. West will read a Paper on "Phosphorus in Cast Iron." This meeting will be held at the Chamber of Commerce, Birmingham, on Friday, February 24, at 7.30 p.m. Mr. J. G. Pearce, Branch-President, will be in the chair.

FRODAIR on the Railways PIGIRON

Best after Test



by courtesy of Chief Mechanical Engineer, Swindon.

FRODAIR IRON & STEEL CO. LTD. Fenchurch House, London.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	28 5 0
Three months	28 10 0
Electrolytic	32 10 0
Tough	30 5 0
Best selected	30 15 0
Sheets	61 0 0
India	41 0 0
Wire bars	33 0 0
Do., March	33 2 6
Do., April	33 5 0
Ingot bars	33 0 0
H.C. wire rods	35 17 6
Off. av. cash, January	28 12 0⅝
Do., 3 mths., January	28 17 10½
Do., Sttlmnt., January	28 12 1⅝
Do., Electro, January	33 10 3⅞
Do., B.S., January	31 7 6
Do., wire bars, January	33 15 8½
Solid drawn tubes	9½d.
Brazed tubes	9½d.
Wire	6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	7⅞d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7⅜d.
Wire	7⅛d.
Rolled metal	6⅝d.
Yellow metal rods	4⅛d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£ s. d.
Standard cash	148 10 0
Three months	148 15 0
English	149 10 0
Bars	152 10 0
Straits	154 15 0
Australian	152 0 0
Eastern	152 7 6
Banca	155 0 0
Off. av. cash, January	145 15 10⅔
Do., 3 mths., January	146 8 11½
Do., Sttlmt., January	145 16 5½

SPELTER.

	£ s. d.
Ordinary	13 15 0
Remelted	13 7 6
Hard	11 10 0
Electro 99.9	16 10 0
English	14 12 6
India	13 7 6
Zinc dust	20 15 0
Zinc ashes	2 7 6
Off. aver., January	14 9 9½
Aver. spot, January	14 7 7⅝

LEAD.

	£ s. d.
Soft foreign ppt.	10 2 6
Empire	10 10 0
English	11 10 0
Off. average, January	10 12 11
Average spot, January	10 9 2

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 0 0
Do., V.M. ex-whse.	23 2 6
Rods	26 0 0
Boiler plates	22 0 0
Battery plates	—

ANTIMONY.

	£ s. d.
English	37 10 0 to 42 10 0
Chinese	27 0 0
Crude	—

QUICKSILVER.

	£ s. d.
Quicksilver	10 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	8 0 0
45/50%	13 15 0
75%	19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 17 6
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£29 5 0
4/6% car.	£23 7 6
6/8% car.	£22 15 6
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£34 15 6
Max. 1% car.	£36 10 0
Max. 0.70% car.	£40 2 6
70%, carbon-free	1/– lb.
Nickel—99.5/100%	£245 to £250
"F" nickel shot	£220 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/– lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 1 6	to 2 2 6
Bundled steel and shrngs.	1 17 6	to 1 19 0
Mixed iron and steel	1 16 6	to 1 19 0
Heavy cast iron	2 4 0	to 2 5 0
Good machinery	2 7 6	to 2 10 0
Cleveland—		
Heavy steel	2 0 0	
Steel turnings	1 12 6	
Cast-iron borings	1 3 6	
Heavy forge	2 10 0	
W.I. piling scrap	2 2 6	
Cast-iron scrap	2 0 0	to 2 3 0
Midlands—		
Light cast-iron scrap	2 0 0	
Heavy wrought iron	2 5 0	
Steel turnings, f.o.r.	1 2 6	
Scotland—		
Heavy steel	1 17 6	
Ordinary cast iron	2 5 0	to 2 6 0
Engineers' turnings	1 11 6	
Cast-iron borings	1 11 0	to 1 12 6
Wrought-iron piling	2 2 6	
Heavy machinery	2 7 6	to 2 9 0

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	21 0 0
Brass	16 0 0
Lead (less usual draft)	9 0 0
Tea lead	7 10 0
Zinc	8 0 0
New aluminium cuttings	74 0 0
Braziery copper	19 0 0
Gunmetal	18 0 0
Hollow pewter	80 0 0
Shaped black pewter	60 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/–
Foundry No. 3	62/6
,, at Falkirk	59/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/–
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/–
,, No. 3 fdry.	66/–
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/–
,, fdry. No. 3	66/–
,, fdry. No. 1	69/–
,, basic	—
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/–
Hem. M/Nos. d/d	66/–
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/–
,, fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/–
Clyde, No. 3	82/–
Monkland, No. 3	82/–
Summerlee, No. 3	82/–
Eglinton, No. 3	82/–
Gartsherrie, No. 3	82/–
Shotts, No. 3	82/–

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.)	9 0 0	to 9 15 0
Nut and bolt iron	7 15 0	
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.	12 10 0	
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	8 0 0	to 9 0 0
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ⅜ in. (Untested)	6 15 0	& up.
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 0 0	
Hoops (Staffs)	9 10 0	& up.
Black sheets, 24g. (10-t. lots)	9 10 0	
Galv. cor. shts.	11 15 0	
Galv. flat shts.	12 5 0	
Galv. fencing wire, 8g. plain	14 0 0	
Billets, soft	5 0 0	to 5 7 6
Billets, hard	6 12 6	to 7 2 6
Sheet bars	4 15 0	to 5 2 6
Tin bars	4 15 0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.50
Wire nails	1.80
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/– to 22/6
,, furnace	16/– to 16/6
Durham and Northumberland—	
,, foundry	21/– to 25/–
,, furnace	13/6 to 13/9
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	16/–
,,	28×20	,,	32/–
,,	20×10	,,	23/–
,,	18¾×14	,,	16/7½
C.W.	20×14	,,	14/–
,,	28×20	,,	29/3 to 29/6
,,	20×10	,,	19/10
,,	18⅞×14	,,	14/–

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Feb.	9 ..	29	1	3	inc.	10/-
,,	10 ..	29	3	9	,,	2/6
,,	13 ..	29	0	0	dec.	3/9
,,	14 ..	28	11	3	,,	8/9
,,	15 ..	28	5	0	,,	6/3

Electrolytic Copper.

		£	s.	d.		
Feb.	9 ..	33	0	0	inc.	5/-
,,	10 ..	33	5	0	,,	5/-
,,	13 ..	33	5	0	No change	
,,	14 ..	32	15	0	dec.	10/-
,,	15 ..	32	10	0	,,	5/-

Standard Tin (cash).

		£	s.	d.		
Feb.	9 ..	149	12	6	inc.	15/-
,,	10 ..	149	15	0	,,	2/6
,,	13 ..	148	7	6	dec.	27/6
,,	14 ..	149	0	0	inc.	12/6
,,	15 ..	148	10	0	dec.	10/-

Tin (English ingots).

		£	s.	d.		
Feb.	9 ..	150	15	0	inc.	15/-
,,	10 ..	150	15	0	No change	
,,	13 ..	149	10	0	dec.	25/-
,,	14 ..	150	0	0	inc.	10/-
,,	15 ..	149	10	0	dec.	10/-

Spelter (ordinary).

		£	s.	d.		
Feb.	9 ..	14	0	0	inc.	5/-
,,	10 ..	14	5	0	,,	5/-
,,	13 ..	13	16	3	dec.	8/9
,,	14 ..	13	16	3	No change	
,,	15 ..	13	15	0	dec.	1/3

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Feb.	9 ..	16	15	0	inc.	5/-
,,	10 ..	16	17	6	,,	2/6
,,	13 ..	16	12	6	dec.	5/-
,,	14 ..	16	10	0	,,	2/6
,,	15 ..	16	10	0	No change	

Zinc Sheets (English).

		£	s.	d.		
Feb.	9 ..	24	0	0	No change	
,,	10 ..	24	0	0	,,	,,
,,	13 ..	24	0	0	,,	,,
,,	14 ..	24	0	0	,,	,,
,,	15 ..	24	0	0	,,	,,

Lead (English).

		£	s.	d.		
Feb.	9 ..	12	0	0	No change	
,,	10 ..	12	0	0	,,	,,
,,	13 ..	11	15	0	dec.	5/-
,,	14 ..	11	15	0	No change	
,,	15 ..	11	10	0	dec.	5/-

Imports and Exports of Iron and Steel Castings, etc., in January, 1933, compared with January, 1932 and 1931.

	January, 1931.	January, 1932.	January, 1933.	January, 1931.	January, 1932.	January, 1933.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pipes and Fittings, Cast	1,306	188	171	16,779	3,151	3,433
Castings, in the Rough, Iron	166	23	7	3,634	467	195
,, ,, ,, Steel	610	247	55	13,555	4,173	778
Hollow-ware, Cast, not Enamelled	9	—	1	654	—	71
,, ,, Enamelled	1	—	3	56	32	167
Exports.						
BUILDERS' CASTINGS—						
To Argentine Republic	103	54	24	5,222	2,406	592
,, Irish Free State	377	415	233	18,640	18,798	10,264
,, British South Africa	157	196	181	6,220	6,824	6,644
,, ,, India	127	73	109	4,324	2,597	3,619
,, New Zealand	62	21	45	4,002	933	1,321
Total (including other countries)	1,281	1,186	954	60,474	50,851	38,339
PIPES AND FITTINGS—CAST—						
To Argentine Republic	851	131	143	8,067	1,281	1,937
,, Irish Free State	644	569	150	8,215	7,583	2,695
,, British South Africa	936	782	437	10,260	9,332	5,054
,, ,, India	139	102	203	3,311	1,688	2,636
,, Straits Settlements and Malay States	77	687	154	1,446	6,359	1,348
Total (including other countries)	6,294	5,940	5,569	74,377	68,944	55,276
HOLLOW-WARE—						
Cast, not Enamelled, and Cast, Tinned	249	166	264	7,846	6,011	8,079
,, Enamelled	38	52	76	3,853	4,375	5,203
CASTINGS, IN THE ROUGH—						
Iron	103	80	43	3,708	3,213	1,564
Steel	154	127	70	6,250	4,066	3,039

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN desires position; experienced in Admiralty contracts, gunmetal, phos. bronze and manganese castings; 12 years foreman in last situation.—Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CHARGE-HAND desires similar position; expert coremaker and loam moulder; 15 years' experience in three different foundries, oil, turbines and reciprocating engines, heavy and medium, also general castings; age 44.—Box 338, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EXECUTIVE or good Sales Position wanted by Patentee, with firm willing to take up manufacture of foundry machinery. Good selling proposition.—Box 336, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman desires position, practical and technical training all branches, grey iron, semi-steel, malleable, all non-ferrous metals, and die-casting. Take entire charge foundry and patternshop.—Box 332, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MALLEABLE and Grey Iron. — THOMAS GOODWIN, Foundry Manager, is now prepared to negotiate for similar position. Would act as representative or adviser. — GOODWIN, "Braeside," Coal Lane, Borrowash, near Derby.

A PROGRESSIVE Company making high-class gas cooking and heating appliances require a man to take charge of their pattern-shop. Applicants must have had experience of light-casting industry, able to speedily and accurately supply patterns (both machine and floor) to a high-production foundry. Strict disciplinarian and good timekeeper essential. To suitable man a permanency.—State wages, references, etc., to Box 346, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN for foundry doing light high-class work, mainly non-ferrous. State age, experience, and give references.—Box 348, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVE wanted, well introduced with industry, for the sale of Plumbago and Blacklead.—Apply to Box 344, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

PRACTICAL Foundry Manager desires engagement. Wide and varied experience, machine tools, light castings, turbine and engine work. Rotary furnace experience. (204)

SITUATIONS VACANT AND WANTED—*Contd.*

POSITION required as Works or Foundry Manager, or as Representative. Wide experience in ferrous and non-ferrous foundries with first-class firms. Highest credentials. (205)

YOUNG Foundry Manager requires position or as Assistant. Good general and technical education, sound experience as Moulder and in supervisory capacity. (206)

PROGRESSIVE position required by young Foundryman with sound practical training on light castings, including stove, grate, bath work, etc. Thorough knowledge machine plate moulding, and also loose pattern moulding. Sound technical training and good general education. (207)

AGENCY.

ENGINEER, with excellent connection amongst foundries in London and the South of England, requires additional agency.—Box 342, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATENT.

THE Proprietor of British Patents Nos. 323845, dated October 30, 1928, and 366320, dated April 13, 1928, relating to "Corrosion Resistant Ferrous Alloy" and "Improvements in Corrosion-Resistant Ferrous Alloys and Method of Making Same" respectively, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patents and ensuring their practical working in Great Britain.—Inquiries to B. Singer, Steger Building, Chicago, Illinois.

MACHINERY.

FOR Sale, 20 Darling & Sellers Moulding Machines. Tables from 30 in. x 20 in. to 42 in. x 24 in., depth of draw varying 14½ in. to 21½ in. In good condition. What offers?—Box 340, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY PLANT FOR SALE.

Pneulec Rotary Sand Drying Plant, output 1 ton per hour.

No. 9 "Ajax" Pneumatic Jarr Ram Turnover P.D. Moulding Machine.

Sand Mill, 6 ft. dia., Stationary Self-discharging Pan.

"Titan" Cupola, 4 to 5 tons; little used.

Brearley Type Sand Disintegrator.

The above are offered at LOW PRICES before removal.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.,
215, Barclay Road, Warley, near Birmingham.
'Phone: Bearwood 1103.

SAND BLASTING PLANTS FOR SALE

Tilghman Sand Blast Room, 6 ft. x 6 ft. x 8 ft. high.

Tilghman Rotary Barrel, 36 in. x 30 in.

Tilghman Rotary Double Barrel Plant, barrels 24 in. x 20 in.

Tilghman 4-ft. 6-in. x 3-ft. Cabinet Plant.

Tilghman 30-in. dia. Cabinet Plant.

Jackman Rotary Barrel, 30 in. x 24 in.

Each Plant complete with Sand Apparatus, Air Compressor and Exhaust Fan.

Large stock of FOUNDRY PLANT at LOW PRICES.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
215, BARCLAY ROAD, WARLEY,
Nr. Birmingham.
'Phone: Bearwood 1103.

MACHINERY—*Continued.*

THOS. W. WARD, LTD.

SAND MOULDING MACHINE, pneumatic, boxes 16" x 16" x 6".

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